struction and Operating Manual
Model X85 Calibrator

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1.0 INTRODUCTION

The Ronan Model X85 Calibrator is a versatile, portable instrument developed to calibrate instruments and systems utilizing current, voltage or ohms inputs and outputs. In addition to the usual mA and volts ranges, the Model X85 has a resistance capability that permits calibration and measuring of Resistance Temperature Detecting (RTD) systems. Input and output variables can be measured with a resolution of 0.01% of range by the intergral 4½ digit meter featuring a liquid crystal display. A meter input/output switch gives the calibrator the capability of monitoring an input variable while simultaneuously supplying a preset, calibrated output signal-a feature facilitating the calibration of signal transmitters. High input-output isolation is maintained while the digital meter is monitoring either input or output variables through the use of isolated floating power supplies. The input terminals are protected against overvoltages of up to 200VDC or peak AC. The highly efficient designs utilized in the Model X85 provide long operating life between charges of the small, lightweight nickel cadmium battery.

The Model X85 provides a set of "2 wire" terminals that allow it to accurately simulate a 2-wire transmitter in a voltage-powered current loop.

2.0 SPECIFICATIONS

INPUT
Voltage, mA or ohms

INPUT IMPEDANCE
Voltage Input: 10 megohms
Current Input: 10 ohms
Ohms Input: 1 mA from internal current source

INPUT/OUTPUT RANGES

0 to 100mV,	10 uV resolution
0 to 1V,	0.1mV resolution
0 to 10V,	1mV resolution
0 to 100 mA, (input)	10 uA resolution
0 to 60 mA, (output)	10 uA resolution
0 to 100 ohms,	0.01 ohm resolution
0 to 1kohm,	0.1 ohm resolution

ACCURACY

Voltage Input/Output ranges:	± 0.025% of range ± 0.025% of reading
60 mA Output:	± 0.04% of range ± 0.025% of reading
100 mA Input:	± 0.025% of range ± 0.025% of reading
100 ohms In/Out:	± 0.07% of range
1 kohm In/Out:	± 0.05% of range

High accuracy internal meter provides input and output readings within stated accuracies.

OUTPUT IMPEDANCE
Voltage Outputs: less than 5 ohms
Current Outputs: greater than 1 megohm

2-WIRE TRANSMITTER OUTPUT
Maximum supply voltage: 40VDC
Maximum load resistance at 24VDC supply and 20 mA signal: 1000 ohms
Accuracy: 0.5% of range with 24VDC supply.

TEMPERATURE EFFECTS
± 0.005% reading, ±0.002% full scale/°C

RECOMMENDED OPERATING TEMPERATURE
0 to +50°C

INPUT/OUTPUT ISOLATION
Up to 300 VRMS isolation provided between input and output on voltage and mA ranges.

WARM-UP TO RATED ACCURACY
30 sec.

POWER REQUIREMENTS
Single, internal 6V rechargeable nickel cadmium battery. Battery charger operates from AC line, 115VAC, 60 Hz (standard) or 220VAC, 50 Hz (optional).

BATTERY LIFE
Greater than 8 hours for mV, volts and ohms input/output ranges and mA input range. Greater than 4 hours on mA range with 20 mA continuous output.

LOW BATTERY INDICATION
"←" on display indicates battery needs recharging.

RECHARGE TIME
14 hours

WEIGHT
3 lbs., 15 oz. (1.79 kg.)

SIZE
8.375" (21.27cm.) high by 4.375" (11.11 cm.) wide by 3.5" (8.89 cm.) deep.

AREA USE CLASSIFICATION
Designed for Class 1, Division 2, Group D locations.

3.0 OPERATION

3.1 OPERATING CONTROLS

Refer to Figure 3-1 for the operating control locations.

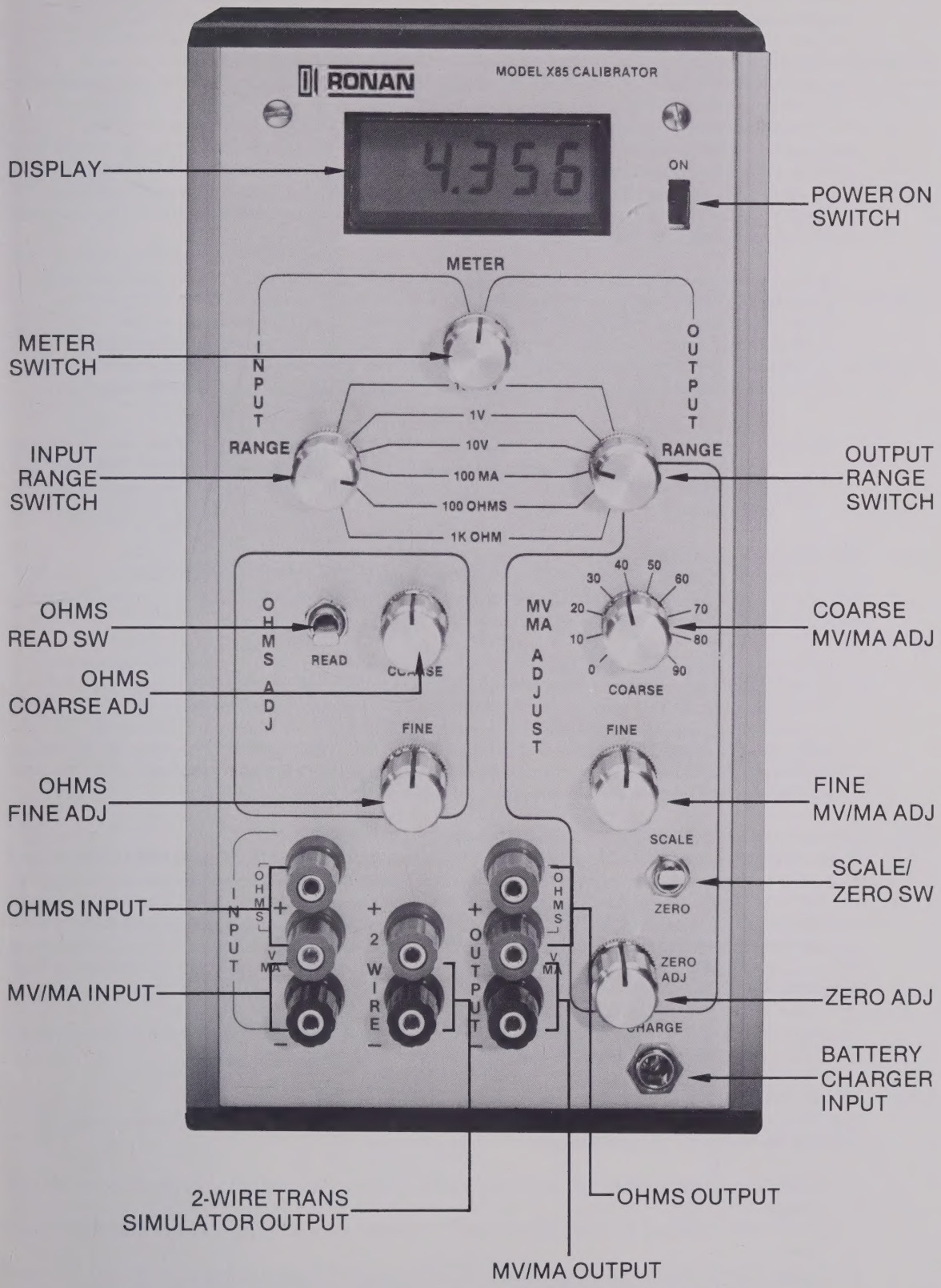

FIGURE 3-1 OPERATING CONTROLS

3.1.1 POWER ON SWITCH
Connects internal nickel cadmium battery to instrument circuits.

3.1.2 METER SWITCH
Two position switch selects either input or output variables for display on the internal digital meter.

3.1.3 INPUT RANGE SWITCH
Six position switch selects input range of measured variable. The METER switch must be in the input position to measure the input variable. A set of input binding posts is provided to connect variables to be measured. A separate set of output terminals is provided for settable output variables. The instrument can provide a previously set output variable at the output terminals while simultaneously measuring a signal at the input terminals.

a) 100mV: Measures DC voltages in the range of 0 to + 100 mV with 10 micro-volt resolution.
b) 1V: Measures DC voltages in the range of 0 to + 1V with 100 microvolt resolution.
c) 10V: Measures DC voltages in the range of 0 to + 10V with 1 millivolt resolution.
d) 100mA: Measures DC current in the range of 0 to 100mA with 10 microamp resolution.
e) 100 ohms: Measures resistances in the range of 0 to 100 ohms with 10 micro-ohm resolution.
f) 1kohm: Measures resistances in the range of 0 to 1000 ohms with 0.1 ohm resolution.

NOTE: The meter will measure accurately to 110% of the above ranges. However, do not use above 110% of range as the meter readout is subject to substantial errors. The meter will also indicate small negative inputs, (up to about 4% of range) so there is no discontinuity at zero.

3.1.4 OUTPUT RANGE SWITCH
Six position switch selects output range of selected variable. The METER switch must be in the OUTPUT position to measure the output, though the output will be maintained at the output terminals when the METER switch is in the INPUT position.

a) 100 mV: Outputs DC voltages in the range of 0 to + 100mV with 10 microvolt resolution.
b) 1V: Outputs DC voltages in the range of 0 to 1 volt with 100 microvolt resolution.
c) 10V: Outputs DC voltages in the range of 0 to 10 volts with 1 millivolt resolution.
d) 100mA: Outputs DC current in the range of 0 to 60mA with 10 microamp resolution.
e) 100 ohms: Outputs resistance in the range of 0 to 100 ohms with 10 micro-ohm resolution.
f) 1kohm: Outputs resistance in the range of 0 to 1kohm with 0.1 ohm resolution.
See OHMS ADJ section for ohms output calibration procedure.

3.1.5 OHMS ADJ, COARSE AND FINE CONTROLS AND READ SWITCH
These controls are used to set the output resistance in either the 100 OHMS or 1KOHM output mode. An isolated, passive resistor is internally connected across the OHMs output terminals. To read the value of this resistance, and adjust it, the METER switch must be in the INPUT position, and input RANGE switch must be in either the 100 or 1KOHM position and the momentary OHMS READ switch must be depressed. The resistor value will now be displayed on the meter and can be adjusted using the 10 turn COARSE and FINE controls. When the READ switch is released the resistor will be switched back to the OHMS output terminals.

CAUTION: If an input is connected, the + input must be removed from the calibrator while depressing the READ switch to measure the ohms output.

3.1.6 MV, MA ADJUST
This section contains the controls used for adjusting the voltage and current output values at the OUTPUT "+" and "–" binding posts.

a) COARSE Select Switch: Ten position switch selects output values in increments of 10% of range.
b) FINE Adj: Provides for fine adjustments of output between steps of the COARSE select switch.
c) SCALE-ZERO Switch: Allows selection of either of two output settings at the output "+" and "–" binding posts. In the SCALE position the output as set on the COARSE and FINE controls is switched to the OUTPUT binding posts. In the ZERO position the output as set on the ZERO ADJ control is switched to the output binding posts.
d) ZERO Adj: Ten turn potentiometer allows setting an independent "zero" value in the range of zero to ten percent of output range.

3.1.7 INPUT/OUTPUT BINDING POSTS

Three binding posts are provided for applying input variables. A red "+" post and a black "–" post are provided to accept voltage and current inputs. A third red post and the red "+" post (ohms) are used to connect resistances to be measured. Three output posts corresponding to the three described above are provided to output voltage, current and ohms. An additional pair of posts labeled "2-WIRE" are used when the calibrator is to simulate a two-wire transmitter. When used as a two-wire transmitter, the OUTPUT RANGE switch must be in the 100MA position.

3.1.8 CHARGE CONNECTOR

Receptacle for battery charger input.

3.2 THERMOCOUPLE INPUTS

The Model X85 can be used to measure thermocouples by using one of the following procedures:

3.2.1 EXTERNAL REFERENCE JUNCTION

Connect the thermocouple to be measured, reference junction and Model X85 calibrator as shown in Figure 3-2, a or b.

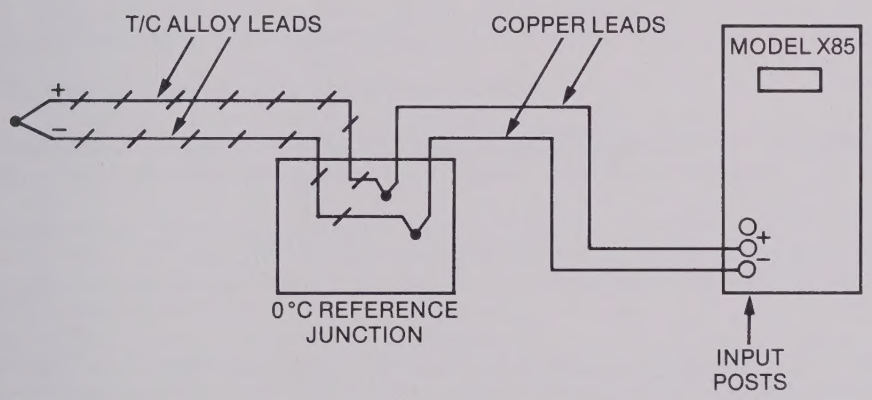

FIGURE 3-2,a

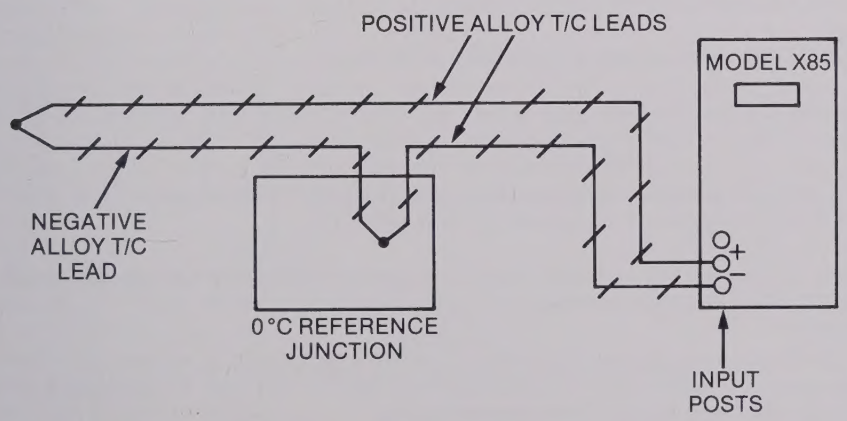

FIGURE 3-2,b
THERMOCOUPLE MEASUREMENTS USING EXTERNAL REFERENCE JUNCTION.

3.2.1.1 Set the METER switch to the INPUT position.

3.2.1.2 Set the INPUT RANGE switch to the 100MV position.

3.2.1.3 Connect the copper or T/C alloy leads from the reference junctions to the V "+" and "–" INPUT posts. For temperatures above 0°C, connect the lead that originates at the T/C positive alloy to the "+" input terminal, the lead originating from the negative polarity alloy (RED) to the input "–" terminal. The T/C voltage is now displayed on the digital meter in mV. The mV reading can now be converted to temperature by consulting the T/C tables. If there is a minus polarity indication on the meter, either the temperature of the T/C is below 0°C or the leads are reversed. In either case, reverse the leads so that a positive reading is obtained on the display. The meter will indicate negative values but is accurate only for positive readings.

3.2.2 DIRECT T/C CONNECTION TO CALIBRATOR

A T/C may be connected directly to the Model X85 calibrator as shown in Figure 3-3.

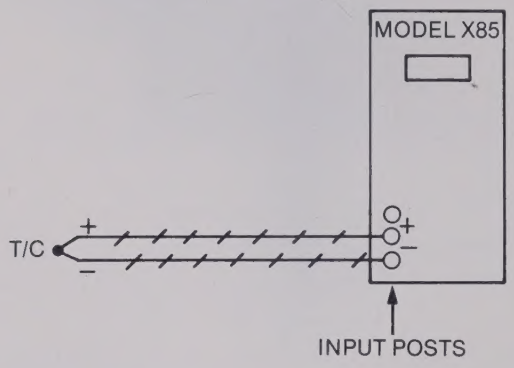

FIGURE 3-3
DIRECT CONNECTION OF T/C TO X85 CALIBRATOR

When this setup is used there is a T/C junction at the binding post of the calibrator which opposes the output of the T/C junctions to be measured. To find the correct "hot" junction temperature this opposition voltage must be determined and added to the voltage indicated on the digital readout.

3.2.2.1 Set the METER Switch to the INPUT position.

3.2.2.2 Set the INPUT RANGE switch to the 100MV position.

3.2.2.3 Connect the T/C positive alloy lead to the "+" INPUT binding post. Connect the T/C negative (RED) alloy lead to the "–" INPUT binding post.

3.2.2.4 Measure with a thermometer the temperature at the INPUT binding posts. (This should be the same as the ambient temperature surrounding the Model X85).

3.2.2.5 Using the T/C tables, look up the MV output for the kind of T/C used at the temperature measured in Step 3.2.2.4. Observe the MV reading on the display and add the MV from the tables to the value on the display.

3.2.2.6 Look up in the T/C tables the total value found in Step 3.2.2.5. The corresponding temperature from the tables is the temperature of the measured T/C.

3.3 THERMOCOUPLE SIMULATION

3.3.1 EXTERNAL REFERENCE JUNCTION

If an external reference junction is to be used, connect the Model X85 and the reference junctions as shown in Figure 3-4.

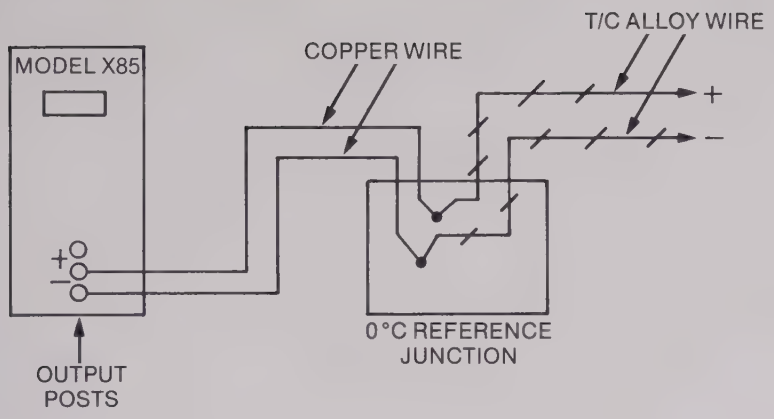

FIGURE 3-4
THERMOCOUPLE SIMULATION USING EXTERNAL REFERENCE JUNCTION

3.3.1.1 Set the METER switch to the output position.

3.3.1.2 Set the OUTPUT RANGE switch to the 100MV position.

3.3.1.3 Set the SCALE-ZERO switch to the SCALE position and adjust the COARSE and FINE output control to the mV value given in the T/C tables for the temperature to be simulated.

NOTE: If the instrument or system to be calibrated, uses an external reference junction to read the T/C inputs, then neither reference junction is required and copper wire can be connected directly between the two. The T/C voltage can be directly set as in Steps 3.3.1.1 through 3.3.1.3.

3.3.2 THERMOCOUPLE SIMULATION WITHOUT USE OF EXTERNAL REFERENCE JUNCTION
Connect the Model X85 to the instrument or system being calibrated as shown in Figure 3.5.

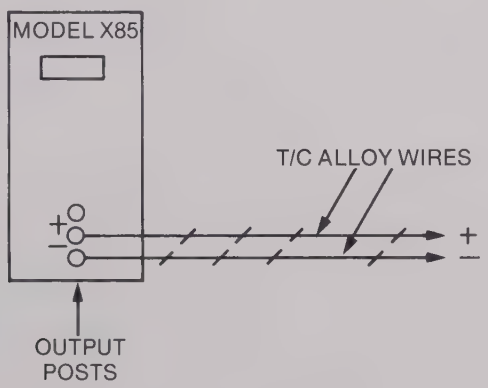

FIGURE 3-5
THERMOCOUPLE SIMULATION USING DIRECT CONNECTION

3.3.2.1 Set the METER switch to the output position.

3.3.2.2 Set the OUTPUT RANGE switch to the 100MV position.

3.3.2.3 Set the SCALE-ZERO switch to the SCALE position.

3.3.2.4 Measure the ambient temperature at the X85 output terminals and lookup in the T/C tables the mV of the T/C being simulated at the ambient temperature measured. (This is an error voltage that is added to the internal voltage generated by the calibrator.

3.3.2.5 Look up in the T/C tables the mV output of the T/C at the temperature to be simulated. Subtract the MV value found in Step 3.3.2.4 from this value.

3.3.2.6 Using the COARSE and FINE output controls, set the answer found in Step 3.3.2.5 on the digital readout. If the answer in Step 3.3.2.5 was negative, reverse the output leads and set the value up as a positive value on the readout.

3.4 2-WIRE TRANSMITTER SIMULATOR

Teminals are provided for 2-wire transmitter simulation. The calibrator is connected to the system to be calibrated as shown in Figure 3-6:

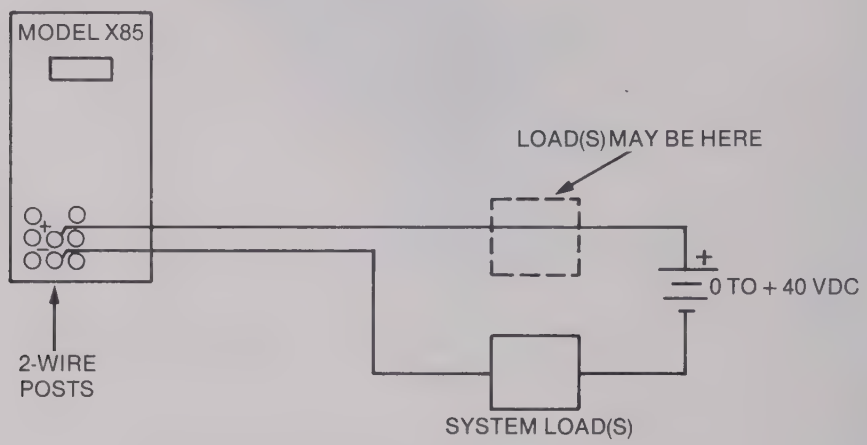

FIGURE 3-6
2-WIRE TRANSMITTER SIMULATION

3.4.1 Set the METER switch to the OUTPUT position.

3.4.2 Set the OUTPUT RANGE switch to the 100MA position.

3.4.3 Set the SCALE-ZERO switch to the SCALE position.

3.4.4 Connect the external current loop to the 2-wire output posts observing polarity as shown in Figure 3-6.

3.4.5 Adjust the COARSE and FINE output controls for the required calibration current.

NOTE: If there is to be repeated calibration between two current levels, the lower current may be adjusted on the ZERO ADJ control and the higher current level may be set up as above. The SCALE-ZERO switch then allows convenient and fast switching between the two current levels.

3.5 TRANSMITTER CALIBRATION

A transmitter with either mV, mA or RTD inputs and mA or V output can be calibrated with the test configurations shown in figure 3-7. The output of the transmitter can be measured while it is receiving a calibration signal from the Model X85.

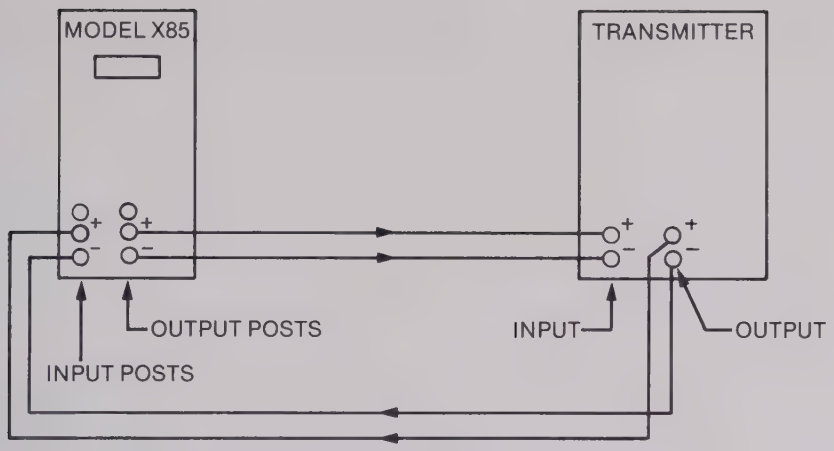

FIGURE 3-7
TRANSMITTER CALIBRATION

3.5.1 Set the METER switch to the OUTPUT position.

3.5.2 Set the OUTPUT RANGE switch to the input variable required by the transmitter to be calibrated.

3.5.3 Set the INPUT RANGE switch to the range corresponding to the output of the transmitter.

3.5.4 Set the SCALE-ZERO switch to the SCALE position.

3.5.5 Connect from the appropriate OUTPUT posts on the calibrator to the input terminals of the transmitter.

3.5.6 Connect from the transmitter output to the V, MA INPUT posts on the calibrator.

3.5.7 Adjust the COARSE and FINE output controls for the required calibration value. (For ohms output see the OHMS ADJ section 3.1.5 for the output calibration precedure).

3.5.8 Set the METER switch to the INPUT position. The transmitter output, corresponding to the calibrated input level from the calibrator, is now displayed on the digital indicator.

NOTE: If there are to be repeated calibrations between two calibration levels, the lower level (0 to 10% of range) may be adjusted on the ZERO ADJ control and the higher calibration level may be set up on the COARSE and FINE controls. The SCALE-ZERO switch then allows convenient and fast switching between the two levels.

3.6 OHMS MEASUREMENT

3.6.1 Set the METER switch to the INPUT position. Set the INPUT RANGE switch to either the 100 OHM or 1K OHM position.

3.6.2 If the calibrator test leads are going to be used, short the ends together and observe the reading on the DPM. (Typically .2 ohms). The test lead resistance should then be subtracted from the total OHMs reading when the unknown resistance is measured. When resistance temperature detectors, (RTD's) are measured, their leads can be a significant percentage of the RTD value. For accurate RTD measurements, the lead resistance should be eliminated, measured, or calculated and subtracted from the total measurement.

3.7 OUTPUT LOOP CURRENT MEASUREMENT

When the Model X85 calibrator is used in the output current mode, (the METER SWITCH in the "OUTPUT" position and the OUTPUT RANGE switch in the 100 MA position) the current flowing externally between the output "+" and "–" binding posts develops a voltage across an internal sense resistor which is in series with the external current loop. The voltage developed across the precision, stable, sense resistor is displayed on the meter in mA units. If the external loop is opened, the current through the sense resistor drops to a very small value, less than 0.1 mA and the display drops from a value, typically 4 to 20 mA, to a very low value. When the external loop is open, an internal amplifier loses its normal feedback signal and causes the small reading on the meter. This internal current is not present when a loop is closed across the output terminals and is not an error component.

3.8 CIRCUIT PROTECTION

The V and OHMS input ranges to the Model X85 calibrator are protected against overvoltages up to ± 200 VDC or peak AC. The input circuits are designed to withstand ± 200V without the use of fuses. The 100 mA input range will withstand overrange currents up to 240 mA. Input currents above 240 mA can cause damage to an internal current sense resistor. (A voltage source capable of supplying 240 mA will produce this current at 2.4V output).

The voltage output ranges are fuse protected against the application of high voltage to the output terminals. This fuse is rated at 125 MA and is located on the FUNCTION SWITCH board. In the 2-wire transmitter simulation mode the output circuits are not fuse protected but are protected against the application of a reverse DC voltage to the 2-wire terminals. The voltage powering a 2-wire current loop that is to be calibrated should be limited to 40 VDC to avoid possible damage to the calibrator. When the OUTPUT RANGE switch is in the 100 mA position, the OUTPUT + post is connected directly to an internal positive power supply. Avoid connecting the OUTPUT + post, either directly or through a low resistance, to the UPPER OHMS input post or to the 2-wire "–" output post. If these posts are connected together, an internal fuse, F1 on the power supply board will blow.

3.9 RECHARGEABLE BATTERY

The Model X85 calibrator is powered by a rechargeable nickel cadmium battery. The battery voltage ranges from 6.5 to 7.5 volts at full charge to about 5.5V at the minimum value before recharging. With proper care, the battery can be expected to last for years.

3.9.1 RECHARGING

WARNING: DO NOT CHARGE IN HAZARDOUS AREAS.

A wall receptable plug-in battery recharger is supplied with the calibrator. The plug on the end of the charger cord is inserted into the receptacle labeled "CHARGE" on the calibrator front panel. A charge time of 14 to 16 hours is recommended to fully charge the battery. Moderate overcharging, for example an extra 24 hours occasionally, should not harm the battery. Care should be taken so as not to leave the instrument recharging for long periods of time.

CAUTION: Use only the recharger supplied with the instrument, the use of another charging system may cause catastrophic damage to the battery.

An internal circuit detects when the battery needs to be recharged and indicates this with a symbol (⟵) on the upper left corner of the display. When this symbol appears, the calibrator should be recharged immediately. Possible cell damage can occur if the battery is allowed to discharge much beyond this. If the calibrator is inadvertently left on for long periods of time and deeply discharged, the following steps should be taken to ascertain if it has undergone an uncorrectable "cell reversal". First, charge the battery for at least 20 hours. Measure the battery voltage with an accurate DVM as follows. See the OUTPUT RANGE switch to the 10V position. Connect the DVM "–" input to the OUTPUT "–" terminal. Carefully touch the DVM "+" input lead to the inside of the CHARGE receptacle. The DVM should indicate more than 6.2V. If the reading on the DVM is below 6.2V, repeat the charge cycle and remeasure the battery. If the voltage is still below 6.2V the battery must be replaced.

CAUTION: Do not short the center pin of the receptacle to the outer shell as this will place a short circuit across the battery.

The battery should not be consistently recharged after only a shallow discharge as it has a discharge cycle memory and will eventually not be able to provide its rated capacity. Occasional shallow discharges or random depth discharges are allowable as long as there are frequent deep discharges and full charge cycles.

4.0 CIRCUIT DESCRIPTION

4.1 GENERAL (Drawing X85-1005)

The major functional blocks of the Model X85 are a 4½ digit meter, a power supply circuit, an output voltage amplifier and an output current amplifier. The digital meter is switched to measure input variables or output variables. The ohms output capability is a passive resistor consisting of two potentiometers that are across the OHMS output terminals.

The circuits are contained on five printed circuit boards including a display board for the digital panel meter. All of the circuits are mounted to the front panel and remain functional when the top cover is removed and the front panel and circuit boards are taken out of the enclosure. Calibration adjustment controls are easily accessible from the back when the circuitry is removed from the enclosure.

4.2 INPUT CIRCUITS (Schematics X85-1000 and X85-1003)

Figures 4-1 a, b, and c are block diagrams of the input measuring circuit in the voltage, current and ohms measuring modes of operation. Volts and mV are applied directly to the DPM measuring circuit. Scaling is accomplished by the input range switch, deck S2-C, in the DPM circuitry. The meter buffer amplifier is included in the auto-zero loop of the DPM giving excellent stability over long time periods and ambient temperature variations. Schematics X85-1000 and X85-1003 show the detailed circuits utilized in the input buffer amplifier and DPM.

Figure 4-1, b illustrates the input current measurement circuit. An internal 10 OHM resistor is connected across the input terminals and the meter amplifier measures the voltage drop across the resistor caused by the input current.

When measuring ohms, Figure 4-1, c, a precision current source is connected to the INPUT + terminal by switch deck S2-B. The current source supplies 1mA through the resistance to be measured and, again, the meter amplifier measures the voltage drop across the resistance.

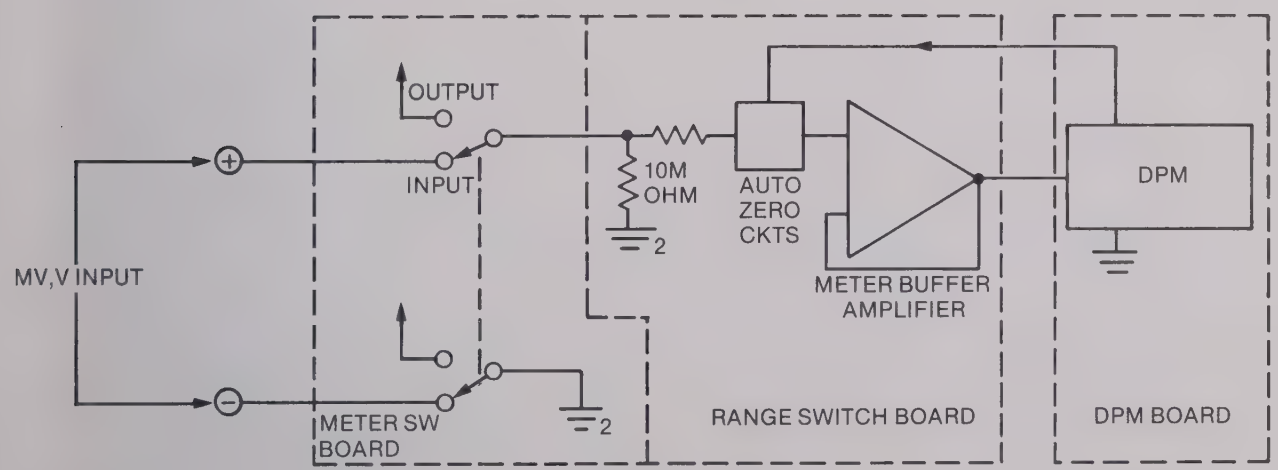

FIGURE 4-1,a
VOLTS INPUT CIRCUIT

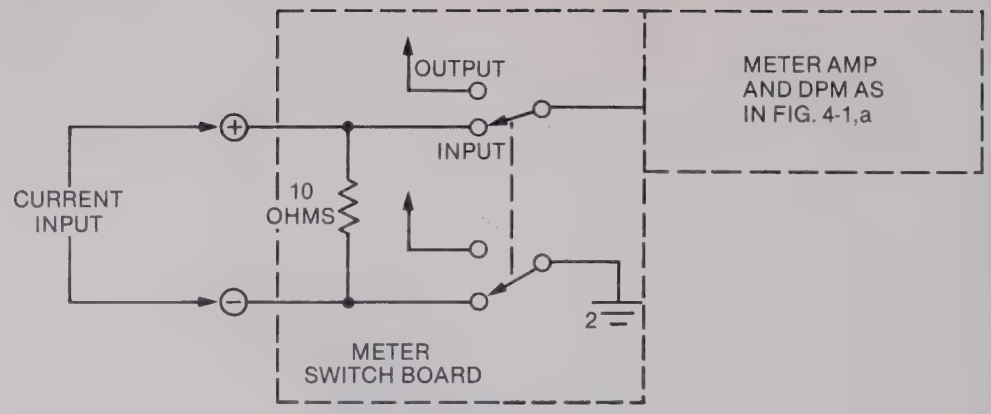

FIGURE 4-1, b
MA INPUT CIRCUIT

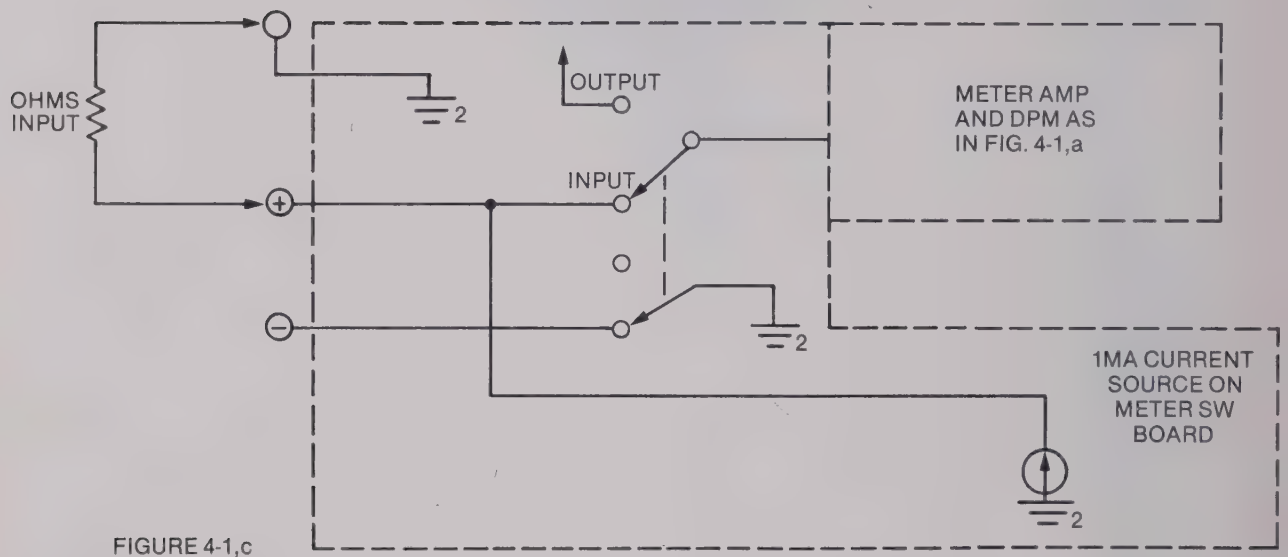

FIGURE 4-1,c
OHMS INPUT CIRCUIT

4.3 DPM BUFFER AMPLIFIER (Schematic X85-1003)

The DPM buffer amplifier consists of amplifier U2 and associated components. Resistor R8 provides protection against high input voltages. The field-effect transistor switches, Q1 and Q3, are synchronized with the DPM timing to include amplifier U2 in the auto-zero loop. Switch Q1 is on only during the integrate up period of the DPM cycle. Switch Q3 is on during the auto-zero and integrate down periods. The voltage waveform at the output of U2, pin 6, is a pulse whose amplitude equals the applied input voltage during the integrate up period and zero at other times. The dual comparator circuit, U4, provides the interface between the DPM and the switches Q1 and Q3. The zero control, R27, provides a small input offset adjustment.

The scaling for the DPM is selected by a deck on the INPUT RANGE switch, S2-C, or by a deck on the OUTPUT RANGE switch, S1-D. Potentiometer R29 is used to adjust the meter accuracy on the 1V range and potentiometer R28 adjusts the accuracy on the 10V range. Switch decks on both the INPUT and OUTPUT RANGE switches, S2-A and S1-B, are used to position the decimal point on the DPM correctly.

4.4 DIGITAL PANEL METER (X85-1006)

The digital panel meter (DPM) performs an analog to digital conversion with 4 ½ digit accuracy utilizing the dual slope conversion method. The digital output is displayed on a 7-segment liquid crystal display. The voltages required to power the DPM enter the card at DIP connector pins 11 (+14V) and 4 (−14V). The +14V is regulated to +5V by R20, CR9 and Q1.

The analog input signal enters the card at connector pin 2 and is applied to the inverting amplifier, U6. Amplifier U6 is used to interface the analog to digital (A to D) converter circuit with the buffer amplifier, U2, and range switching circuitry on PC board X85-1003. During the initial portion of the A to D conversion period, "auto-zero", the voltage offsets of the buffer amplifier and U6 are sampled and subsequently cancelled out during the input signal integration period.

There are two "auto zero" circuit loops, one consisting of the circuitry contained in the A to D chip set, U3 and U9 and one around U2 on the RANGE SWITCH board and U6 on the DPM board. The BUSY signal, which goes high during the autozero period controls the autozero circuits external to the A to D chip set. During autozero, switches "A" and "C" of U1 are ON, switch "B" OFF, and the offset voltage at the output of U6 is stored on capacitor C4. During the "integrate up" period switches "A" and "C" of U1 are OFF and switch "B" is ON. This applies the stored offset voltage to the inverting input of U6 cancelling the offset voltages that were present during the autozero interval.

The clock for the A to D converter is made up of U5A and B, R5, R6, R7 and C2. The proper clock frequency is 50 kHz (20 microseconds/clock). The clock is applied to U3 which provides the logic control and switches for the A to D conversion cycle. Integrated circuit U9 contains the analog section of the A to D converter: a buffer amplifier, an amplifier used for the integrator and a comparator circuit.

A latch-decoder-driver circuit, U8, is used to take the BCD data from U3 and drive the 7-segment LCD displays. The AND Gates U4-A, B, C and D are used to eliminate race conditions when transferring data to the latches in U8. The OR Gates in U10 cause an over-range number to be latched into U8 when the input exceeds 200% of full scale. The flip-flop consisting of U11 controls the most significant digit of the display which is either a "1" or is blanked.

The full scale indication of the display is defined as 10,000 counts or a display of 1-0-0-0-0 (location of decimal point variable) though the DPM will indicate up to ± 1-9-9-9-9. Any input signal above this (over-range) will have a unique display indicating the over-range condition. All inputs are conditioned by the buffer amplifier, U2, on the range switch board and U6 on the DPM board for a full scale voltage of 1V at the DPM input. The required reference voltage for this input, 1V, is provided by the reference zener, CR8 and the stable voltage divider made up of R3 and R4. The reference adjust resistor, R22, is adjusted for a full scale readout (100.00) when 100.00 mV is applied to the input and the input range switch is in the 100mV position (See Section 5: CALIBRATION).

A voltage translation circuit between U3, Pin 28 and U1 is provided by one of the comparators of the dual comparator, U2. The second comparator of U2 provides the required interface signals to U4 on the RANGE SWITCH board through J4. This signal called "UP" at J4, Pin 5 is used to control the buffer amplifier on the RANGE SWITCH board, i.e., the buffer amplifier is caused to be in the auto-zero or normal mode of operation.

4.5 VOLTAGE OUTPUT AMPLIFIER (Schematics X85-1003 and X85-1004).

The voltage output circuit consists of amplifier U1 and associated components on Schematic X85-1003 and a reference voltage and input resistors on Schematic X85-1004. From Schematic X85-1003, resistors R1, R2 and R4 are output range select resistors and transistor Q2 is the output stage. Resistor R11 limits the short circuit output current to about 60 MA. Diodes CR1, 2, 5 and 6 provide protection against the application of a large voltage across the output binding posts. Fuse F1 will blow if the applied voltage is above about 12.5 volts at 125 MA.

The output FINE and COARSE ADJUST controls are shown on shematic X85-1004. A precision reference voltage is generated by zener diode CR8, amplifier U2-A and associated components. Potentiometer R20 is used to adjust the voltage at pin 7 of U2-A to −4.0 volts with respect to output ground. (2-wire output "−" binding post.)

The ten position switch, S1, on Schematic X85-1004, provides the COARSE output adjustment steps and potentiometer R10 allows a fine adjustment of the output voltage between the steps of the COARSE control. The SCALE/ZERO switch, S2, selects either the COARSE and FINE output circuits or the ZERO ADJ control circuit, R14, to be connected to the summing junction of the voltage output amplifier, U1, of Schematic X85-1003.

4.6 CURRENT OUTPUT AMPLIFIER (Schematic X85-1003)

The current output amplifier consists of amplifier U3, field-effect transistor Q4, transistor Q5 and

associated components. The current output amplifier receives a signal from the voltage amplifier, U1, in the range of 0 to 1 volt. The output of U3 controls the current output stage, Q5 through Q4. The output current flows through R12 developing a voltage that is fed back to the minus input of U3 (pin 2). The amplifier always maintains an equality between the voltages at pin 3 and pin 2, therefore the current flowing through R12 (and the output current loop) is controlled by the voltage applied to input pin 3. Resistors R20 and R22 and CR8 provide a voltage feedback when there is no external loop connected to the current output binding posts. Refer to section 3.7 for direct output loop current measurement.

4.7 CURRENT SOURCE (Schematic X85-1002)

Schematic X85-1002 contains the current source used for ohms measurements and the METER SWITCH. The METER SWITCH is a five pole, two position switch that connects the digital panel meter to measure INPUT or OUTPUT values.

Amplifier U1 and associated components make up a precision 1 mA current source that is connected to the INPUT + post when the INPUT RANGE switch is in one of the ohms input positions. A stable input voltage from the reference zener, CR3, is applied to the inverting input of U1 through R3. Amplifier U1 controls the conduction of transistor output stage Q1 so that the voltage at U1, pin 2 is equal to the voltage at U1, pin 3. The reference voltage of CR3 is thereby dropped across the stable resistor, R3 causing 1 mA to flow through the output stage consisting of Q1 and Q2. Potentiometer R7 provides a means of adjusting the voltage of CR3. The diode CR3 protects the circuitry against positive input voltages in excess of +200V. Transistors Q1 and Q2 have large breakdown voltage ratings and will withstand the applications of large negative voltages to the ohms input terminals up to 200 volts without damage.

4.8 POWER SUPPLY (Schematic X85-1004)

The power supply utlizes the 6 volt potential from the battery and generates the voltages required to operate the calibrator. A non-saturating DC-DC converter consisting of transformer T1, oscillator, U1, field-effect transistors Q1 and Q2 and the secondary rectifiers and filters perform the voltage conversion. Integrated circuit U1 is a symmetrical oscillator operating at about 20 KHz. The oscillator alternately turns on the V-MOS switches, Q1 and Q2, which switch the 6V battery to both sections of the primary winding of transformer T1. Two separate power supplies are provided: plus and minus V2 which operate the DPM and DPM input amplifier, and plus and minus V3 which operate the voltage and current output amplifiers. The secondary voltage at winding 4-5 of T1, and full wave rectified by BR1, is added in series with the 6V battery to generate +V3.

The comparator, U2B, and associated components monitor the battery voltage and send a signal to the panel meter to indicate when the battery needs to be recharged. When the battery is low, the output of U2B goes from high to low and couples a signal across the opto-isolator, U3 to the DPM board.

5.0 CALIBRATION

5.1 CALIBRATION INTERVAL

The Model X85 calibrator's accuracy, as set at the factory, should hold for an indefinite period. However, it is recommended that its performance be checked at six month intervals against accurate standards to insure that it is performing within its rated specifications. Internal adjustments should not be performed without an accurate measurement of the performance with precision laboratory equipment to establish the need for recalibration. The calibrator may be returned to RONAN ENGINEERING COMPANY for recalibration, or it can be recalibrated in any standards laboratory.

5.1.1 CALIBRATION SEQUENCE

Any recalibration should follow the procedures of steps 5.3.1 through 5.3.7 in sequence. The accuracy of the mA and ohms measurements depends on the accuracy of the digital meter when measuring voltage. Although there are adjustments for the accuracy of the mA and ohms measurements, these should not be performed until the input voltage measurement accuracy is validated by performing calibration step 5.3.2.

5.2 EQUIPMENT REQUIRED

The calibration set-ups described below are selected to require the minimum amount of precision

equipment. Alternate test configurations can be used if the equipment is sufficiently accurate. (0.01% of reading or better)

a) Secondary DC voltage standard, ± 0.005% R ± 50 microvolts or better
b) Precision, stable resistor, 100 OHMs ± 0.005%
c) Digital Voltmeter, or null meter with 100 microvolt resolution or better
d) Stable, adjustable power supply capable of 50 mA output current, or adjustable current source

5.3 CALIBRATION PROCEDURE

5.3.1 REMOVAL OF CIRCUITRY FROM ENCLOSURE

The tests outlined in the following sections can be performed without removing the calibrator from its enclosure. If adjustments need to be made, then remove the front panel and attached circuit boards from the enclosure by removing the four screws in the top plate, then the top plate, then slide the front panel assembly out of the enclosure.

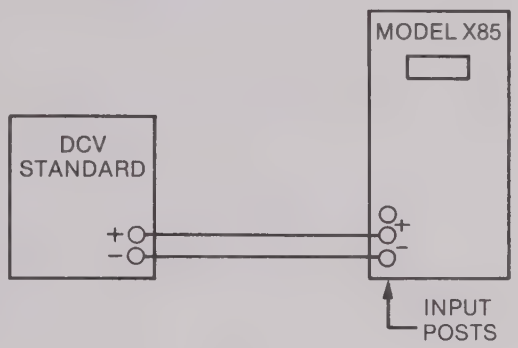

FIGURE 5-1
INPUT VOLTAGE TEST

5.3.2 INPUT VOLTAGE MEASUREMENT

5.3.2.1 Connect the X85 calibrator and the DC voltage standard as shown in Figure 5.1.

5.3.2.2 Set the calibrator METER switch to the INPUT position. Set the INPUT RANGE switch to the 100MV position.

5.3.2.3 Set the polarity switch of the DC standard to "0" or short the calibrator " + " input lead to the " – " input lead. If the calibrator DPM does not indicate zero, ± 2 digits, adjust R27 on the RANGE SWITCH board. Refer to Figure 5.2 for the location of the adjustment controls.

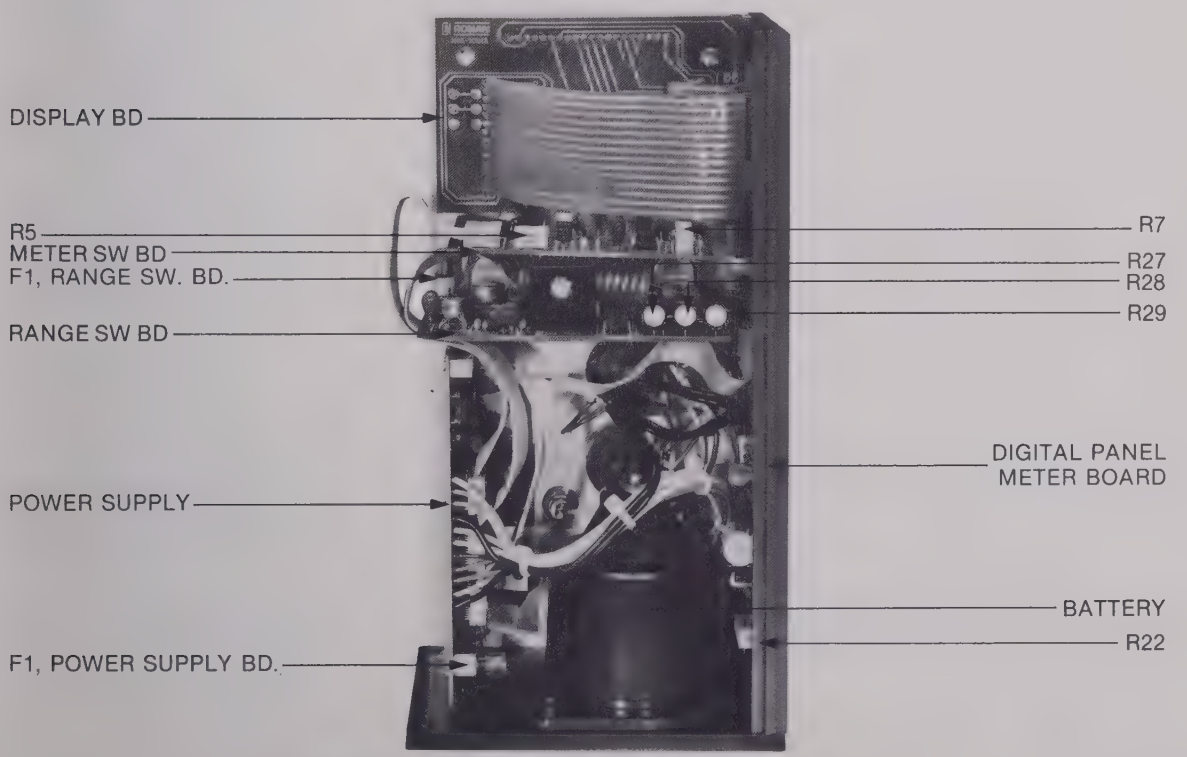

FIGURE 5-2 LOCATION OF CALIBRATION CONTROLS

5.3.2.4 Set the polarity switch of the DC standard to the " + " position and reconnect the inputs to the Model X85, if necessary. Set the DC calibrator to 0-.1-0-0-0V. If the DPM on the Model X85 doesn't read within 100.00mV ± .05 MV, adjust R22 on the DPM board for 100.00 ± .02MV.

5.3.2.5 Set the INPUT RANGE switch to the 1V position. Repeat step 5.3.2.4 using a setting of 1-.0-0-0-0 on the DC voltage standard (there is no separate ZERO control for the 1 and 10V ranges). If the full scale readout on the DPM doesn't indicate within 1.0000 ± .0005V, then R29 on the RANGE SCALE board should be adjusted for 1.0000 ± .0002V.

5.3.2.6 Set the INPUT RANGE switch to the 10V position. Repeat step 5.3.2.4 using a setting of 10-.0-0-0-0 on the DC voltage standard. If the full scale readout on the DPM doesn't indicate within 10.000 ± .005V, then R28 on the RANGE SW board should be adjusted for 10.000 ± .002V.

5.3.3 INPUT CURRENT MEASUREMENT

5.3.3.1 Connect the X85 calibrator and the DC voltage standard as shown in Figure 5-3.

CAUTION: Set the power supply output to zero before connecting it into the circuit.

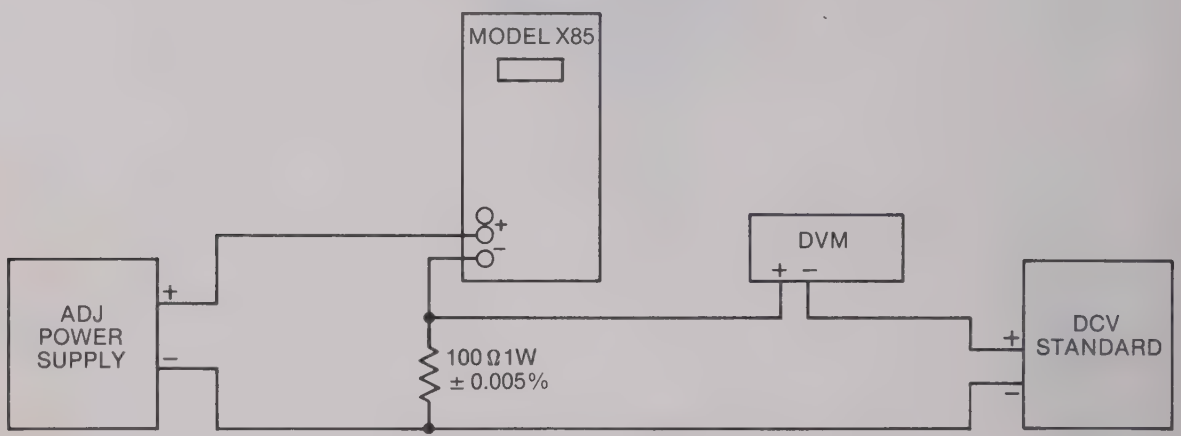

FIGURE 5-3
CURRENT MEASUREMENT VERIFICATION

5.3.3.2 Set the METER switch on the calibrator to the INPUT position. Set the INPUT RANGE switch to the 100MA position.

5.3.3.3 Slowly turn up the power supply until the Model X85 indicates approximately 50 mA (the exact value of this current isn't important).

5.3.3.4 Adjust the DC voltage standard until a null is obtained on the digital volt meter (zero ± 200 microvolts — set the DVM to a scale with 100 microvolt resolution).

5.3.3.5 The setting of the DC voltage standard divided by 100 equals the DC mA flowing into the Model X85's input. The readout of the Model X85 should equal the setting of the voltage standard divided by 100 ± .04 mA. Potentiometer R5 on the METER SWITCH board may be used to adjust the Model X85's readout if necessary.

5.3.4 OHMS MEASUREMENT

Connect the Model X85 and the precision 100 OHM resistor as shown in Figure 5-4. Connect the resistor directly to the OHMs input binding posts of the Model X85 to eliminate errors caused by lead lengths.

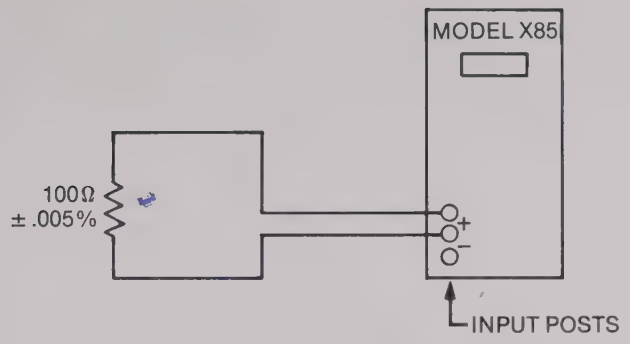

FIGURE 5-4
OHMS MEASUREMENT VERIFICATION

5.3.4.2 Set the METER switch to the INPUT position. Set the INPUT RANGE switch to the 100 OHMs position. The readout of the Model X85 should indicate 100.00 ± .07 OHMs. Potentiometer R7 on the meter switch board may be used to adjust the OHMs accuracy if necessary.

5.3.5 OUTPUT VOLTAGE CALIBRATION
The output voltage is settable by the COARSE and FINE output controls and is measured by the internal panel meter. The output voltage setting is within the error limits of the digital panel meter.

5.3.6 OUTPUT CURRENT ACCURACY

5.3.6.1 There are no calibration adjustments in the current output circuit; the accuracy depends on the accuracy of the input voltage measurement of the IV range as calibrated in section 5.3.2.5, and a precision wire wound resistor on the range switch board, R12. To verify the accuracy of the current output, connect the Model X85 in the test configuration of figure 5.5.

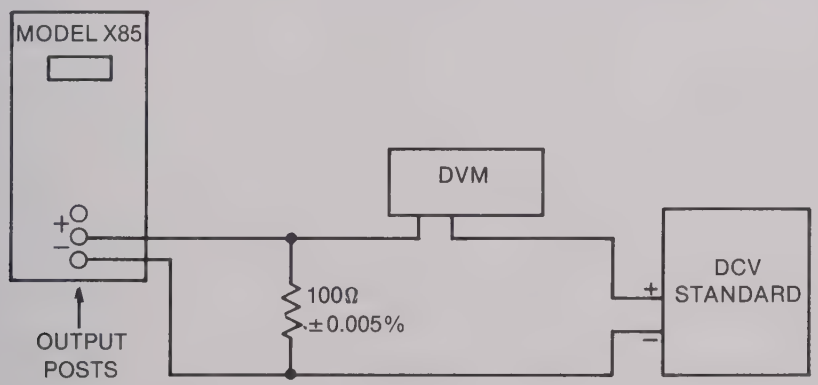

FIGURE 5.5
CURRENT OUTPUT VERIFICATION

5.3.6.2 Set the Model X85's METER switch to the OUTPUT position. Set the OUTPUT RANGE switch to the 100 MA position. Set the SCALE/ZERO switch to the SCALE position. Set the DVM to a range that has 100 microvolt resolution. Set the DC VOLTAGE STD to 100 MV.

5.3.6.3 Set the DC VOLTAGE STD to 5-.0-0-0-0 volts. Set the Model X85 OUTPUT COARSE control to 50 and adjust the FINE control for an output of 50.00 MA as indicated on the Model X85's panel meter. The DVM should indicate zero ± 4 MV.

5.3.7 OHMS OUTPUT

Two precision potentiometers are connected across the OHMs output terminals except when the OHMs READ switch is pressed down (they are then switched to the OHMS INPUT terminals). The value of this resistor is as indicated on the Model X85 panel meter with the METER switch in the INPUT position and the INPUT RANGE switch in either the 100 OHMs or 1K OHM position, and the READ switch pressed down. The accuracy of this reading is the same as the OHMS MEASUREMENT accuracy of 5.3.4.

6.0 TROUBLESHOOTING GUIDE

Table 6-1 is given to assist at troubleshooting for some specific malfunctions. For further assistance refer to the schematics and circuit description sections of this manual. RONAN ENGINEERING COMPANY does maintain a service and repair department where the calibrator may be sent for repair and recalibration.

NOTE: When the front panel and circuit boards are removed from the enclosure, inspect the three DIP connectors on the power supply board to ensure that the plugs are firmly seated.

ABNORMALTY	POSSIBLE CAUSE	CORRECTIVE ACTION
NO DISPLAY	a) low or bad battery	Charge battery, then measure battery voltage per section 3.9.1. If battery voltage is good, check fuse, F1, on the power supply board.
No voltage output. Display indicates output voltage.	F1, range sw board	Check fuse, F1, on range switch board.
No current output in 100 MA position, voltage output ok.	Q4, Q5, U3, CR7 or associated components. Range switch board.	Replace defective component.
Display erratic on both input & output settings.	Meter buffer amp or DPM board.	Use schematic and text to assist in locating defect.
Gross inaccuracy when measuring OHMs. Voltage measurements ok.	Q1, Q2, U1 and associated components meter switch board.	Replace defective component.
Gross inaccuracy when measuring current. Voltage measurements ok.	Resistor R1, R2, or R5 on meter switch board.	Replace defective components.

7.0 BATTERY REPLACEMENT

Model X85 calibrators, serial numbers 11212 and up, utilize an easily exchangable, rechargable battery pack for power. The battery pack is removable for interchanging or replacement by turning out the two captive screws in the bottom cover, removing the battery pack and unplugging the attached cord. A replacement battery pack can then be quickly installed. The battery pack can be charged when it is installed in the Model X85 calibrator or when it is removed from the calibrator as the charger will plug directly into the battery pack.

DISPLAY BOARD
X85-1001-2

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1	1		P. C. Bd	X85-1001A	
2					
3	1	Hamlin	U1	4 1/2 Digit LCD Display .25" Long Pins	390 9-313-010
4	1	Stackpole	S1	Slideswitch DPDT	S9022CD00-0
5					
6	14	AMP		"F" Posts, Strip of 10	1-380953-3
7					
8	1	AMP		Jumper Cable 2" 14 Cond.	1-88665-3
9	1	AMP		Jumper Cable 4.5" 14 Cond.	1-88684-3
10					
11	4	A.B.	R1, 2, 3, 4	Resistor, 1/4W, 5% 220K	RC07GF224J

METER SWITCH BOARD
X85-1002-2

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1	1			P.C. Board	X85-1002C
2	1	Amp		15 Conductor Flex Cable 4.5" Long	1-88684-4
3	1	Richey Elect.		Dip Cable, 14 Pin, 5" Long	X85B11-2
4	1	Grayhill	S1	Switch, 4 Pole, 2 Pos	71BY231999
5					
6	1	A.B.	R6	Resistor, 1/4W, 5% 220 Ohm	RC07GF221J
7	2	A.B.	R4, R8	Resistor, 1/4W, 5% 12K	RC07GF123J
8	1	Mepco	R2	Resistor, 1/8W, 1% 1K Ohm	RN55C1001
9	1	Jordan	R1	Resistor, Wire Wound 10 Ohm	J135-10 ± 0.1%
10	1	Jordan	R3	Resistor, Wire Wound 2.46K	J110-2.46K ± 0.1%
11	1	Beckman	R7	Potentiometer, Cermet 20K	89PR20K
12	1	Beckman	R5	Potentiometer, Cermet 1K Ohm	72P1K
13					
14	2	Fairchild	CR1, CR2	Diode, Signal	IN4148
15	1	Fairchild	CR4	Diode, Rectifier	IN4005
16	1	National	CR3	Diode, Zener 2.46V	LM336Z
17					
18	1	National	Q1	H.V. Transistor, NPN	92PU10
19	1	Motorola	Q2	H.V. Transistor, PNP	2N6519, MPSA92
20					
21	2	ITT	C1, C2	Capacitor, Tant. 6.8MFD/35V	TAGA6.8K35
22	1	Arco	C3	Capacitor, Dipped Mica 220pfd	DM15-221J
23					
24	1	National	U1	OP Amp	LM308N

POWER SUPPLY BOARD
X85-1004-2

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1				P.C. Board	X85-1004B
2					
3			1		
4					
5	1	A.B.	R26	Resistor, 1/4W, 5% 2.7K	RC07GF272J
6	2	A.B.	R15, 21	Resistor, 1/4W, 5% 8.2K	RC07GF822J
7	3	A.B.	R17, 18, 19	Resistor, 1/4W, 5% 27K	RC07GF273J
8					
9	1	Mepco	R8	Resistor, 1/8W, 1% 2.21K	RN55C2211
10	1	Mepco	R7	Resistor, 1/8W, 1% 2.87K	RN55C2871
11	1	Mepco	R6	Resistor, 1/8W, 1% 3.83K	RN55C3831
12	1	Mepco	R5	Resistor, 1/8W, 1% 5.36K	RN55C5361
13	1	Mepco	R4	Resistor, 1/8W, 1% 8.06K	RN55C8061
14	1	Mepco	R3	Resistor, 1/8W, 1% 13.3K	RN55C1332
15	1	Mepco	R22	Resistor, 1/8W, 1% 12.4K	RN55C1242
16	1	Mepco	R23	Resistor, 1/8W, 1% 15K	RN55C1502
17	1	Mepco	R2	Resistor, 1/8W, 1% 26.7K	RN55C2672
18	1	Mepco	R24	Resistor, 1/8W, 1% 33.2K	RN55C3322
19	2	Mepco	R13, 16	Resistor, 1/8W, 1% 17.8K	RN55C1782
20	1	Mepco	R1	Resistor, 1/8W, 1% 80.6K	RN55C8062
21	2	Mepco	R11, 12	Resistor, 1/8W, 1% 140K	RN55C1403
22	1	Mepco	R25	Resistor, 1/8W, 1% 20.5 K	RN55C2052
23	1	Jordan	R9	Resistor, W.W. 17.87 ± o,1%	J110-17.87K ± 0.1%
24	1	Beckman Electro	R20	Potentiometer, Cermet 20K	89PR20K
25	2	Techniques	R10, 14	Potentiometer, Wire Wound 50K	850-10T 50K
26					
27	7	Fairchild	CR1, 2, 3, 4, 5, 6, 7	Diode Signal	IN4148
28	1	National	CR8	Diode Zener 2.49V	LM336Z
29	2	Siliconix	Q1, Q2	V MOS Power FET	VN66AF
30	1	Arco	C6	Capacitor, Dipped Mica 390pfd	DM15-391J
	1	Sprague	C7	Capacitor, Disc .05/500V	5HK-S50
31	5	ITT	C1, 2, 3, 4, 5	Capacitor, Tant. 6.8MFD/35	TAGA6.8K35
32	1	National	U2	Amplifier/Comparator	LM392N
33	1	TI	U3	Opto Isolator	TIL119
34	1	RCA	U1	Mono/Astable Multivibratior	CD4047BE
35	1	C & K	S 2	SPDT Switch	7101P3DAB
36					
37	1	Mag Devices	T1	Transformer	X85B1
38					
39	1	Grayhill	S1	Switch, 1 Pole, 10 Pos	71BY232025
40	1	Varo	BR1	Rectifier Bridge	VE47
41	1	Littlefuse	F1	Fuse, 500 MA	273.500
42	1	Littlefuse		Fuse Holder	281005
43	2	Circuit Ass'y. Corp.	J1, J3	IC Socket, 14 Pins, Low Profile, Gold Plated	CA-14L S2-10SD
44	1	Circuit Ass'y. Corp.	J2	IC Socket, 16 Pins, Low Profile, Gold Plated	CA-16L S2-10SD

DPM BOARD
X85-1006-2

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1	1			P.C. Board	X85-1006A
2	1	Richey		Dip Conn. Cable, 14 Pin, 6"	X85B11-3
3	2	AB	R18,19	Resistor, 1/4W, 5%, 47 Ohm	RC07GF470J
4	1	AB	R20	Resistor, 1/4W, 5%, 5.6K	RC07GF562J
5	2	AB	R16,21	Resistor, 1/4W, 5%, 10K	RC07GF103J
6	2	AB	R8,11	Resistor, 1/4W, 5%, 36K	RC07GF363J
7	1	AB	R13	Resistor, 1/4W, 5%, 22K	RC07GF223J
8	4	AB	R6,14,15,-23	Resistor, 1/4W, 5%, 100K	RC07GF104J
9	1	AB	R10	Resistor, 1/4W, 5%, 300K	RC07GF304J
10	1	AB	R9	Resistor, 1/4W, 5%, 470K	RC07GF474J
11					
12	1	Mepco	R7	Resistor, 1/8W, 1%, 19.1K	RN55C1912
13					
14	1	Mepco	R17	Resistor, 1/8W, 1%, 150K	RN55C1503
15					
16	1	Beckman	R22	Potentiometer, Cermet, 20K	89PR20K
17	1	Beckman	R5	Potentiometer, Cermet, 20K	72P20K
18					
19	1	Jordan	R1	Resistor, Wire Wound, 12.47K	J110-12.47K + 0.1%
20	1	Jordan	R2	Resistor, Wire Wound, 125K	J110-125K + 0.1%
21	1	Jordan	R3	Resistor, Wire Wound, 7.30K	J110-7.3K + 0.1%
22	1	Jordan	R4	Resistor, Wire Wound, 5.0K	J110-5.0K + 0.1%
23	1	Mepco	R12	Resistor, 0.1%, M. Film, 125K	RN55C1253
24					
25	2	Arco	C3,6	Capacitor, Dipped Mica, 100 pfd	DM15-101J
26	2	Arco	C2,5	Capacitor, Dipped Mica, 220 pfd	DM15-221J
27	5	ITT	C4,8,9,10,12	Capacitor, Tantalum 6.8mfd/35V	TAGA6.8K35
28	1	ITT	C7	Capacitor, Tantalum 1mfd/35V	TAGA1.0K35
29	1	Mepco	C1	Capacitor, Polyester, .1mfd	C280MAH/A1M
30					
31	1	Sth. Elect.	C11	Capacitor, Polypropylene, .33mfd + 10%, 200V	MPP11-.33 + 10%-200V
32					
33	1	National	CR8	Diode Zener, 2.49V	LM336Z
34	2	Fairchild	CR6.7	Diode, Signal	1N4148
35	5	Fairchild	CR1,2,10,-11,12	Diode, Low Leakage	1N457A
36	2	Motorola	CR3,9	Diode, Zener, 1N752A, 5.6V	1N752A
37	2		CR4,5	Jumper	
38					
39	1	National	Q1	Transistor, NPN	2N6715
40	1	National	U2	Dual Comparator	LM393N
41	2	National	U6,7	Op Amp	LM308N
42	2	RCA	U5,11	Quad 2-Input Nand Gate	CD4011BE
43	1	RCA	U12	Quad Exclusive Or Gate	CD4070BE
44	1	RCA	U10	Quad 2-Input Or Gate	CD4071BE
45					
46	1	Intersil	U3	Logic Circuit (½ of Pair)	ICL71C03CPI or ICL71C03ACPI
47	1	Intersil	U9	Analog Circuit (½ of Pair)	ICL8052CPD or ICL8052ACPD
48	1	Intersil	U8	Latch/Decoder/Driver	ICM7211IPL
49	1	RCA	U1	Quad Switch	CD4066BE
50	1	RCA	U4	Quad 2-Input Nand Gate	CD4081BE

X85 FRONT PANEL AND ENCLOSURE PARTS

ITEM NO.	QTY REQ'D.	MFG. CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1	1	C & K	Switch (Ohms Read)	7209P3YZQ
2				
3	1	D & B Power	Battery Charger	NB50-5 Charger w/60BO65 Cord, Hole +
4	5	H.H. Smith	Miniature Binding Posts, Red	3015-102
5	3	H.H. Smith	Miniature Binding Posts, Black	3015-103
6				
7	1	Switch-Craft	Receptable	712A
8	1	Gould	Battery, NiCad	6.0V/450B
9	8	Kurtz-Kasch	Knobs	32013
10	8	H.H. Smith	Ring Nut	1120
11	2	H.H. Smith	Spacers 3/8 Long, 4-40 Thd.	8402
12				
13	1	Mallory or Sprague	Capacitor Clamp	VR6B-Mallory 4-36-14M-Sprague
14	1	Electro Techniques	100 Ohm Pot	850-10T-100 Ohms
15	1	Electro Techniques	1K Ohm Pot	850-10T-1K Ohms
16	2		Test Lead Sets, Mini-Plug to STD Alligator Clips	
17				
18	1	Ronan	Battery Pack	X85B8
19	1	Ronan	Bottom Cover	X85B9
20	1	Ronan	Front Panel	X85C10
21	2	Ronan	Side Extrusion	X85C5
22	1	Ronan	Top Cover	X85B6
23	1	Ronan	Back Plate	X85C7
24	1	Ronan	Display Window	X85A4
25				
26	1	Sprague	Capacitor, Ceram. Disc. .05MFD/500V	5HK-S50

RANGE SWITCH
X85-1003-2

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1	1		P. C. Bd	X85-1003D	
2	1	Richey Elect		Dip Cable, 16 Pin, 6"	X85B11-7
3	1	A.B.	R17	Resistor, 1/4W, 5% 33 OHM	RC07GF330J
4	1	A.B.	R7	Resistor, 1/4W, 5% 22 OHM	RC07GF220J
5	1	A.B.	R5	Resistor, 1/4W, 5% 220 OHM	RC07GF221J
6	1	A.B.	R22	Resistor, 1/4W, 5% 5.6K	RC07GF562J
7	1	A.B.	R20,	Resistor, 1/4W, 5% 10K	RC07GF273J
8	5	A.B.	R6,13, 21, 23, 24	Resistor, 1/4W, 5% 27K	RC07GF273J
9	1	A.B.	R16	Resistor, 1/4W, 5% 18K	RC07GF183J
10	2	A.B.	R14, 15	Resistor, 1/4W, 5% 470K	RC07GF474J
11	2	A.B.	R3, 18	Resistor, 1/4W, 5% 10M	RC07GF106J
12	1	A.B.	R11	Resistor, 1W 5% 270 OHM	RC32GF271J
13	1	Mepco	R1	Resistor, 1% M. Film 402 OHM	RN55C4020
14	1	Mepco	R2	Resistor, 1% M. Film 4.02K	RN55C4021
15	1	Mepco	R4	Resistor, 1% M. Film 40.2K	RN55C4022
16	1	Beckman	R28	Potentiometer, Cermet, 1T	82PAR50
17	1	Beckman	R29	Potentiometer, Cermet, 1T	62PA500
18	1	Beckman	R27	Potentiometer, Cermet, 1T	62PA100K
19	1	Ultex	R8	Resistor, 3W, 5% 16.6K	UT-2A-16.6K
20	1	Jordan	R12	Resistor, Wire Wound ±0.01% 10 OHM	J110-10 ± 0.01%
21	1	Jordan	R25	Resistor, Wire Wound ±0.1% 12.47K	J110-12.47K ± 0.1%
22	1	Jordan	R19	Resistor, Wire Wound 102.27K	J110-102.27K ± 0.1%
23	1	Jordan	R10	Resistor, Wire Wound 112.0K	J110-112.0K ± 0.1%
24	1		R9	Jumper	
25	1	Arco	C8	Capacitor, Dipped Mica 5 PFD	DM15-050J
26	1	Sprague	C7	Capacitor, Ceram. Disc. .001MFD	5GA-D10
27	1	Sprague	C3	Capacitor, Dipped Mica .005MFD	TG-DSO
28	4	ITT	C1, 2, 5, 6,9	Capacitor, Tant. 6.8MFD/35V	TAGA6.8K35
29	2	Kemet	C4, C9	Capacitor, Ceram. .05MFD	C321C503Z-SU1CA
30	1	MOT	CR7	Diode, Rectifier	IN4005
31	1	Fairchild	CR8	Diode, Low Leakage	IN457A
32	2	Fairchild	CR5, 6	Diode, Signal	IN4148
33	2	Motorola	CR1, 2	Diode, Zener - 12V	IN5349A
34					
35	1	National	Q2	Transistor, NPN	92PU01A
36	1	Motorola	Q5	Transistor, NPN	MJE243
37	3	Motorola	Q1, 3, 4	Field-Effect Trans. N CH.	MPF4392, 2N44392
38	1	Thermalloy		Heat Sink (Q5)	6073B
39					
40	2	National	U2, U1	OP-Amp, Low Power	LM312H
41	1	Fairch	U3	OP-Amp	μa714HC
42	1	National	U4	Dual Comparator	LM393N
43	1	Grayhill	S1	Switch, 6 Pole, 6 Pos	71BY231998
44	1	Grayhill	S2	Switch, 4 Pole, 6 Pos	71BSF30-2-2-6N
45	1	Littlefuse	F1	Fuse 125 MA	273.125
46	1	Littlefuse	F1	Fuse Holder	281005

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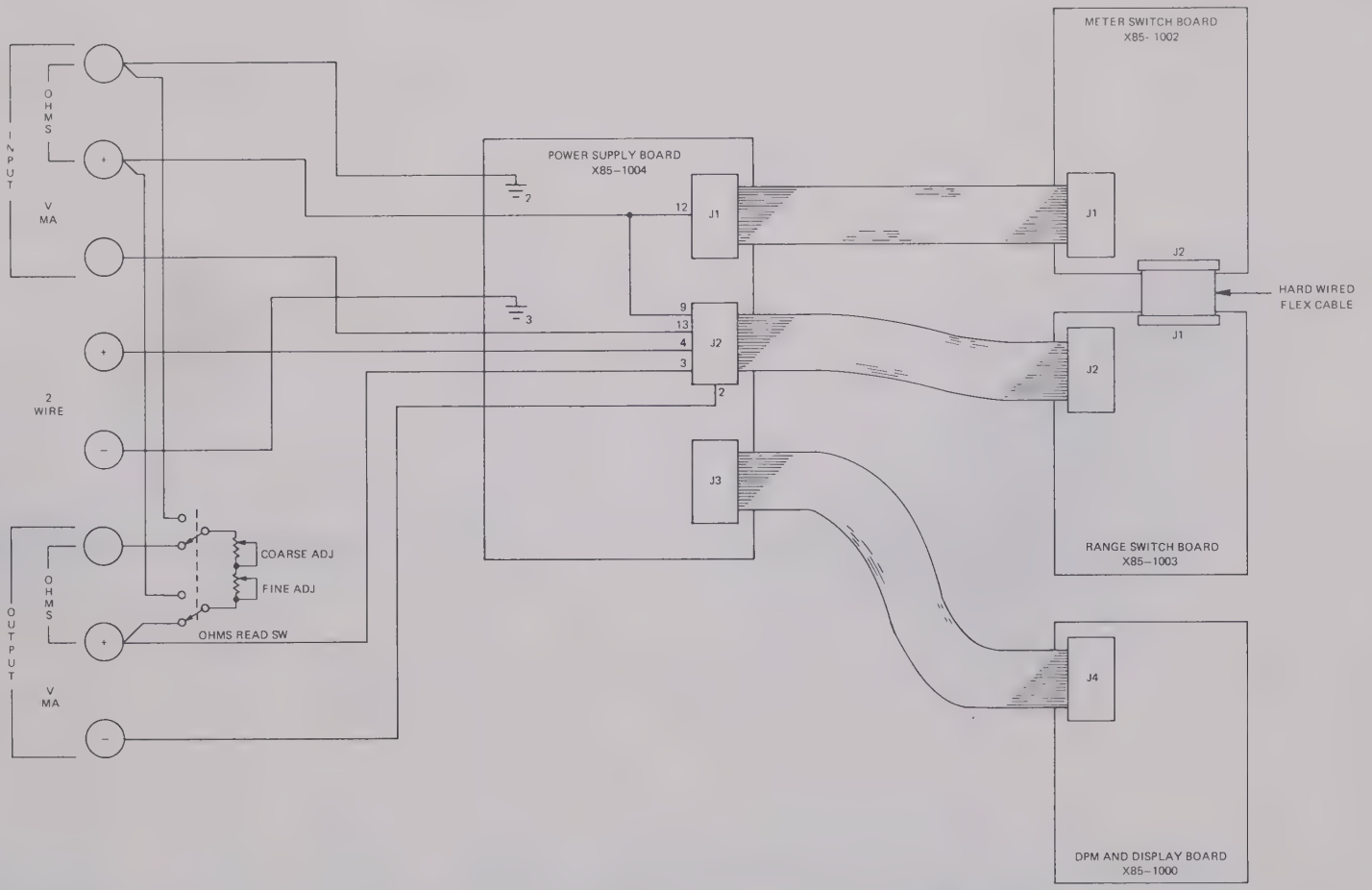
REV NO.	DESCRIPTION	DATE



ITEM NO.	QTY	CODE / PART NUMBER	DESCRIPTION	SPEC
			LIST OF MATERIALS	

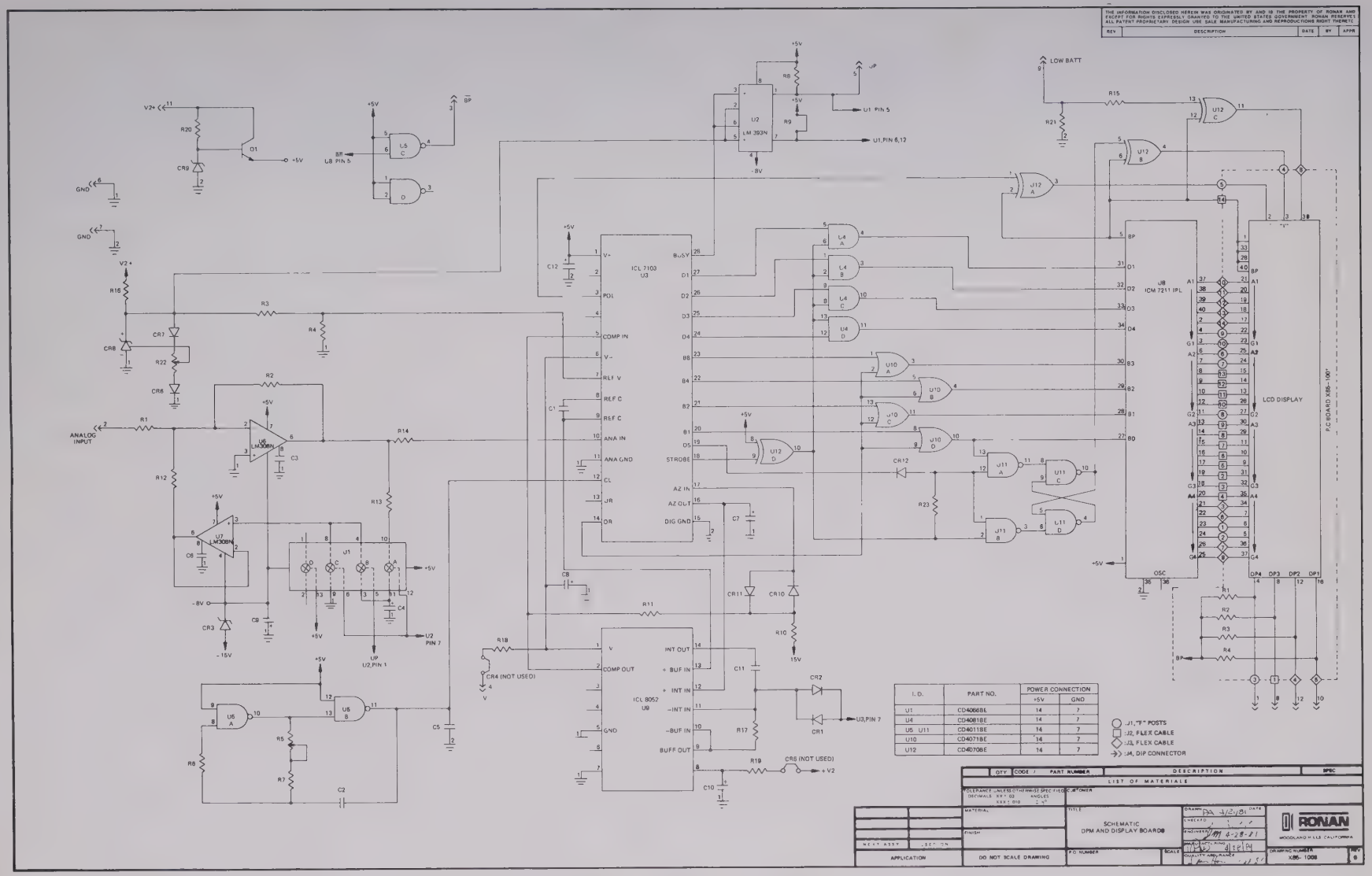
TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMALS XX ± .03 ANGLES
XXX ± .010 ± ½°

CUSTOMER

		MATERIAL	TITLE: INTERCONNECTION DRAWING MODEL X85	DRAWN CRW 1-29-81 DATE
				CHECKED
		FINISH		ENGINEER 1-30-81
NEXT ASSY	USED ON			MANUFACTURING
APPLICATION		DO NOT SCALE DRAWING	P.O. NUMBER / SCALE	QUALITY ASSURANCE

RONAN
WOODLAND HILLS CALIFORNIA

DRAWING NUMBER X85 1005 REV 0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REV
DESCRIPTION
DATE
BY
APPR
ANALOG INPUT
ICL 7103 U3
ICM 7211 IPL
U8
LCD DISPLAY
P.C. BOARD X85-1001
ICL 8052 U9
LOW BATT
LM308N
LM 393N
CD4066BE
CD4081BE
CD4011BE
CD4071BE
CD4070BE
I. D.
PART NO.
POWER CONNECTION
+5V
GND
U1
U4
U5 U11
U10
U12
J1, "F" POSTS
J2, FLEX CABLE
J3, FLEX CABLE
J4, DIP CONNECTOR
QTY
CODE / PART NUMBER
DESCRIPTION
SPEC
LIST OF MATERIALS
SCHEMATIC
DPM AND DISPLAY BOARD8
DO NOT SCALE DRAWING
RONAN
WOODLAND HILLS CALIFORNIA
DRAWING NUMBER
X85-1008
REV
8

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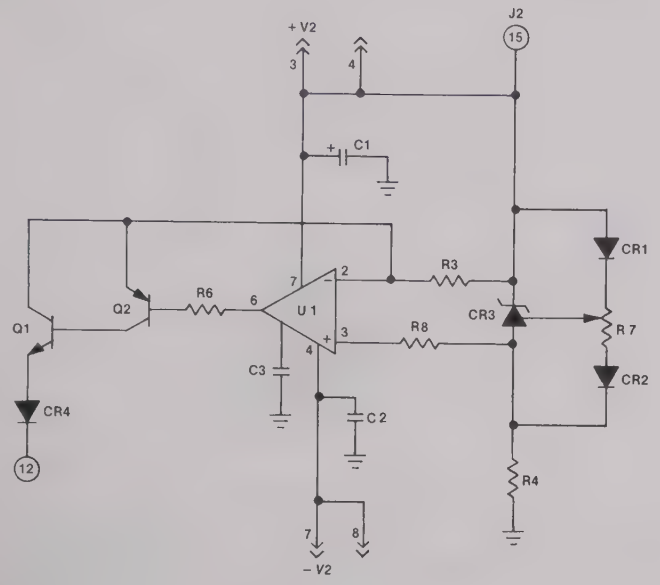
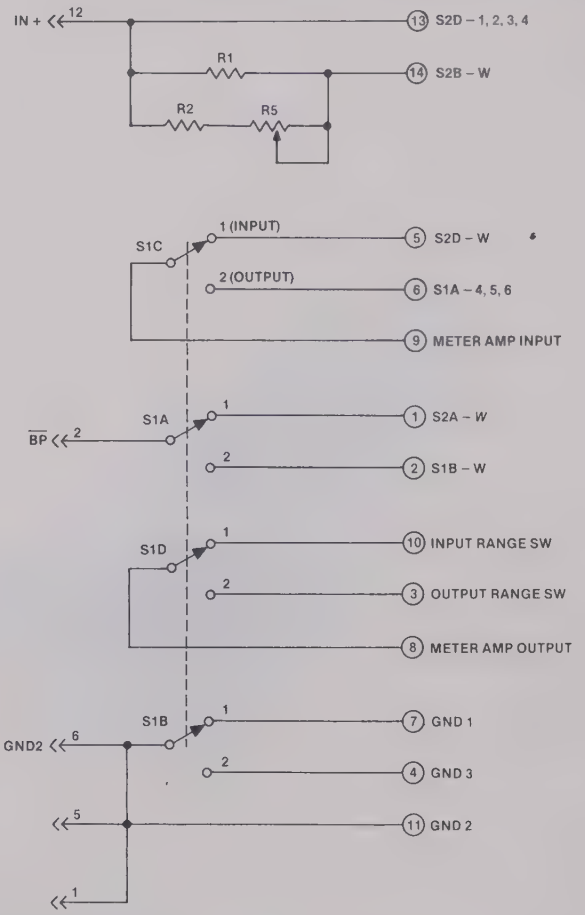
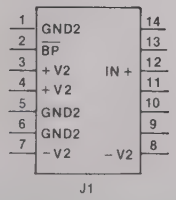
REV. NO.	DESCRIPTION	DATE	BY







NOTE:

◯ = FLEX STRIP TO RANGE SW BD

⟶» = DIP CONN TO P.S. BD

ITEM NO.	QTY	CODE / PART NUMBER	DESCRIPTION	SPEC.

LIST OF MATERIALS

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMALS XX ± .03 XXX ± .010 ANGLES ± ½°

CUSTOMER

MATERIAL

FINISH

TITLE: METER SWITCH BOARD

DRAWN

CHECKED

ENGINEER

MANUFACTURING

QUALITY ASSURANCE

DATE

RONAN
WOODLAND HILLS, CALIFORNIA

NEXT ASSY | USED ON

APPLICATION

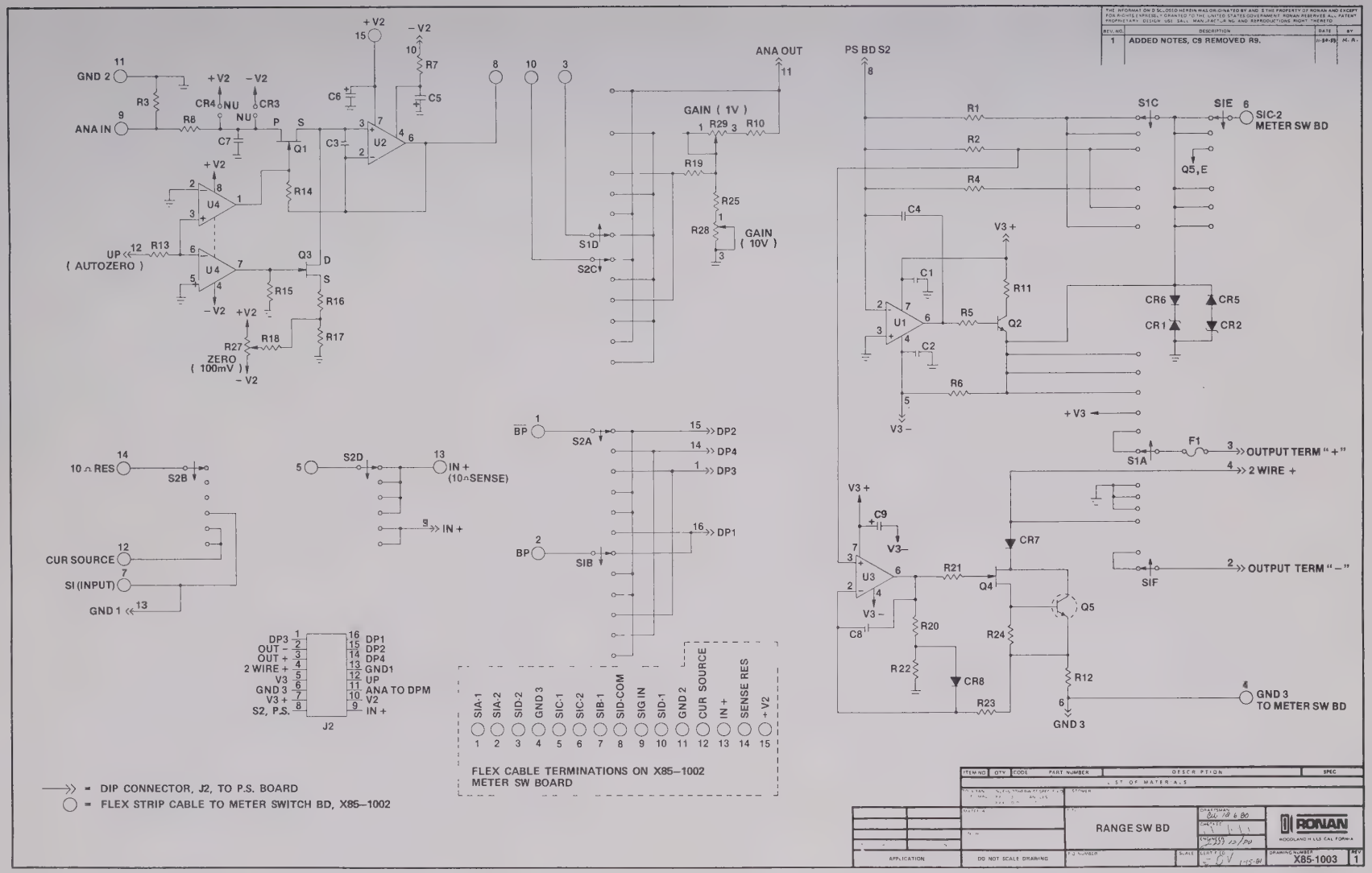
DO NOT SCALE DRAWING

P.O. NUMBER

SCALE

DRAWING NUMBER: X85-1002

REV: 0


GND 2
ANA IN
+V2
-V2
R3
R8
C7
Q1
C3
C6
C5
R7
U2
U4
UP
(AUTOZERO)
R13
R14
R15
R16
R17
R18
R27
ZERO
(100mV)
Q3
ANA OUT
GAIN (1V)
R29
R10
R19
R25
R28
GAIN
(10V)
S1D
S2C
PS BD S2
S1C
SIE
SIC-2
METER SW BD
R1
R2
R4
Q5,E
C4
C1
C2
R11
R5
Q2
U1
V3+
V3-
R6
CR6
CR5
CR1
CR2
+V3
S1A
F1
OUTPUT TERM "+"
2 WIRE +
OUTPUT TERM "-"
SIF
C9
CR7
U3
R21
Q4
Q5
R20
R24
R22
CR8
R12
R23
C8
GND 3
TO METER SW BD
10Ω RES
S2B
CUR SOURCE
SI (INPUT)
GND 1
S2D
IN + (10Ω SENSE)
IN +
BP
S2A
SIB
DP2
DP4
DP3
DP1
DP3
OUT -
OUT +
2 WIRE +
V3
GND 3
V3 +
S2, P.S.
J2
GND1
UP
ANA TO DPM
V2
IN +
SIA-1
SIA-2
SID-2
GND 3
SIC-1
SIC-2
SIB-1
SID-COM
SIG IN
SID-1
GND 2
CUR SOURCE
IN +
SENSE RES.
+V2
FLEX CABLE TERMINATIONS ON X85-1002
METER SW BOARD
= DIP CONNECTOR, J2, TO P.S. BOARD
= FLEX STRIP CABLE TO METER SWITCH BD, X85-1002
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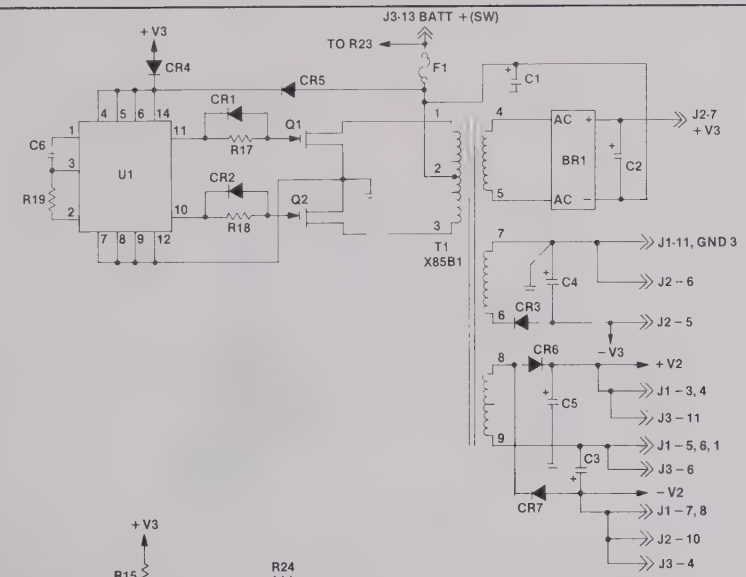
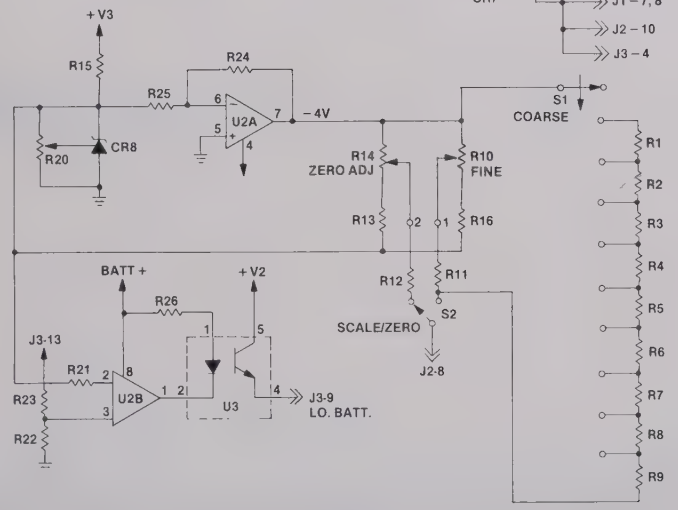
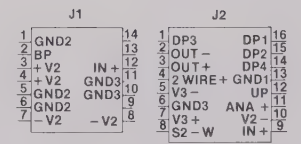
REV. NO. 1
DESCRIPTION: ADDED NOTES, C8 REMOVED R9.
DATE: 9-29-80
BY: M. R.
ITEM NO | QTY | CODE | PART NUMBER | DESCRIPTION | SPEC
LIST OF MATERIALS
RANGE SW BD
DRAWN: DC 10 6 80
CHECKED:
ENGINEERING:
APPLICATION
DO NOT SCALE DRAWING
J.O. NUMBER
SCALE
RONAN
WOODLAND HILLS CALIFORNIA
DRAWING NUMBER: X85-1003
REV: 1

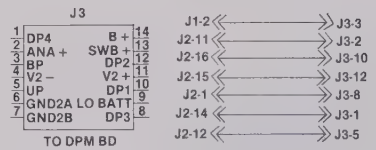




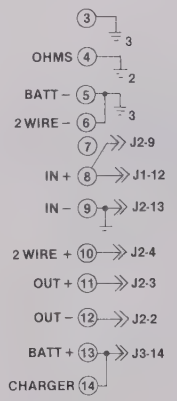


TO METER SW BD

TO RANGE SW BD



TO DPM BD



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REV	DESCRIPTION	DATE	BY	APPR

QTY	CODE	PART NUMBER	DESCRIPTION	SPEC

LIST OF MATERIALS

MATERIAL	TITLE: POWER SUPPLY & INTERCONNECT BD	DRAWN	DATE
FINISH		CHECKED	
NEXT ASSY		ENGINEER	
APPLICATION	DO NOT SCALE DRAWING	MANUFACTURING	
	PO NUMBER	SCALE	QUALITY ASSURANCE

RONAN
WOODLAND HILLS CALIFORNIA

DRAWING NUMBER X85-1004 REV 0

RONAN WARRANTY

RONAN warrants equipment of its own manufacture to be free from defects in material and workmanship, under normal conditons of use and service, and will replace any component found to be defective, on its return, transportation charges prepaid, within one year of its original purchase. This warranty carries no liability, either expressed or implied, beyond our obligations to replace the unit which carries the warranty. Expendable parts, i.e. batteries, fuses, and test leads, are excluded from this warranty.

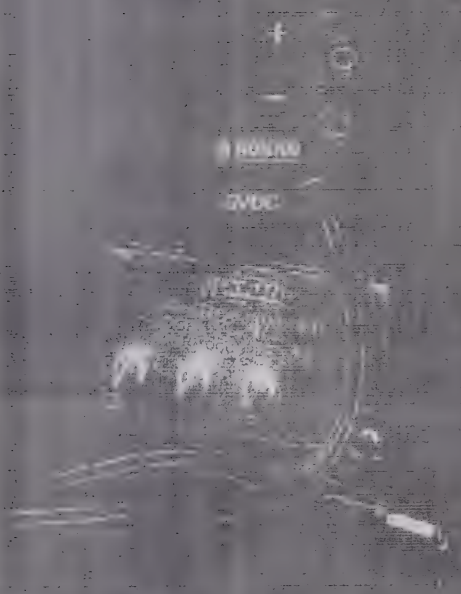
Note: Specifications and designs subject to change without notice.

X85IOM/1283

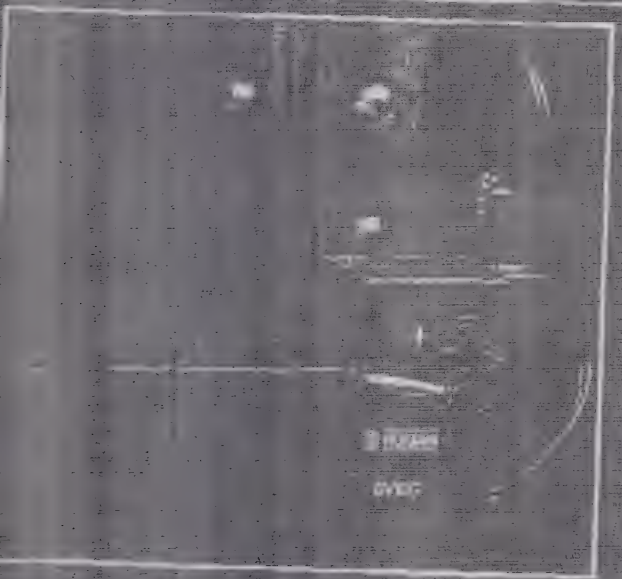
Printed in U.S.A.

10:57AM RONAN ENGINEERING LA

Reference Junction Model X85-RJ



- Direct connection to X85 Calibrator INPUT and OUTPUT binding posts
- Highly accurate 0°C reference junction
- Very low power requirements
- Independent remote reference junction using X85 battery pack
- Allows direct millivolt reading of thermocouple signal
- Simulate thermocouple with direct millivolt X85 output setting



RONAN

Model X85-RJ

[illegible] for offset caused by connection of the [illegible] wires to the binding posts of the Model X85 Portable Calibrator can now be made using the Model X85-RJ Reference Junction. Use of the X85-RJ eliminates the need for an ice bath or the tedious mathematics involved in measuring the ambient temperature at the binding posts, looking up the equivalent millivolt offset and adding this number to the reading. The X85-RJ plugs directly into the input or output binding posts and derives its [illegible] Battery in the X85 Calibrator [illegible] lack of the 0°C Reference [illegible] which allows thermocouple [illegible] read on the front panel meter [illegible] input to an external system [illegible] binding network using [illegible] resistor provides an offset voltage that compensates for the error voltage at the [illegible] of the Thermocouple wire and the [illegible]

Specifications

1.0 Thermocouple Types:
E, J, K, T, R or S

1.1 Reference Junction Temperature:
[illegible]

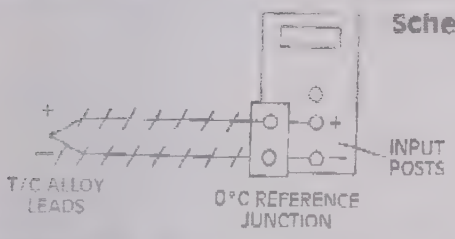
1.2 Impedance in series with "+" Input:
Less than 125 Ohms

1.3 Accuracy:
± 0.2°C at 25 ± 5°C ambient
± 0.5°C from 15°C to 35°C ambient

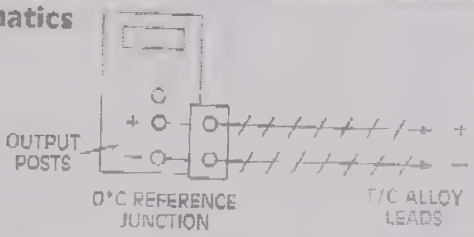
1.4 Power:
Derives power from [illegible] Battery. Internal voltage converter maintains isolation between Reference Junction and X85 battery. 6 ± 0.3 VDC at 5 mA

1.5 Size:
2.25" (5.72cm)L X 1.375" (3.50cm)W X 1.125" (2.86cm)H

Schematics



[illegible] measurement using thermocouple input [illegible] with the X85-RJ Reference Junction. [illegible] a read as direct millivolt reading.



Thermocouple simulation using the X85-RJ Reference Junction. Temperature is simulated by direct millivolt setting as an output of the Model X85 Calibrator.

Ordering Information

Model X85-RJ-( )
Type of Thermocouple used—
E, J, K, T, R, S

RONAN

[illegible]
P.O. Box 1275
21300 Oxnard Street
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RONAN ENGINEERING
TEST DEPARTMENT

X85-RJ TEST PROCEDURE

MODEL X85 REFFRENCE JUNCTION

1.0 TEST EQUIPMENT

1.1 SCHEMATIC [XA5-1007
1.2 ICE POINT REFERENCE — KAYE INST # K1500 C
1.3 THERMOCOUPLE WIRES
1.4 RONAN X95
1.5 VARIABLE POWER SUPPLY WITH CURRENT LIMITER
1.6 DC VOLT STANDARD

2.0 SET UP #1

2.1 HOOK UP DC VOLT STANDARD TO ICE POINT REFFERENCE
2.2 HOOK UP T.C. WIRES FROM ICE POINT REF TO REF JUNCTION TERMINALS
2.3 PLUG REF JUNCTION TO X85 INPUTS TEMINALS
2.4 PLUG REF JUNCTION POWER CORD TO X85 " CHARGE "
2.5 REMOVE BATTERY
2.6 HOOK UP POWER SUPPLY TO X85' CHARGE "CONNECTOR

3.0 POWER SUPPLY SET

3.1 POWER SUPPLY = 7 V [MORE VOLTAGE WILL DAMAGE X85]
3.2 CURRENT LIMITER = 0.15 A

4.0 REF JUNCTION CALIBRATION

4.1 INPUT = 0.00 MV
4.2 OUTPUT = 0.00 MV +/- 30 UV READING ON X85 [ADJUST R
4.3 INPUT = 100.00 MV
4.4 OUTPUT = 100.00 MV +/- 30 UV

5.0 LINEARITY TEST

5.1 INPUT = 0 TO 100 MV [INCREMENTED EVERY 10 MV]
5.2 OUTPUT = 0 TO 100 MV +/- 30 UV

6.0 POWER SUPPLY TEST

6.1 POWER SUPPLY = 5.5 V [X85 LOWER LIMIT]
6.1 INPUT = 0.00 MV
6.2 OUTPUT = 0.00 MV +/- 40 UV READING ON X85
6.3 INPUT = 100.00 MV
6.4 OUTPUT = 100.00 MV +/- 40 UV

7.0 SET UP #2

7.1 OPEN X85 REF JUNCTION BOX [NEW TYPE PLUG THE GAP COVER]
7.2 PLUG REF JUNCTION

[illegible]

[illegible]

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No. of Pages 2

Used on Product X85/X86 CALIBRATORS

Part Schematic X85-1007 Revision

Assembly Drawing Revision

Responsible Engineer JM

Released For Material Procurement and Prototype Run _____ Date _____

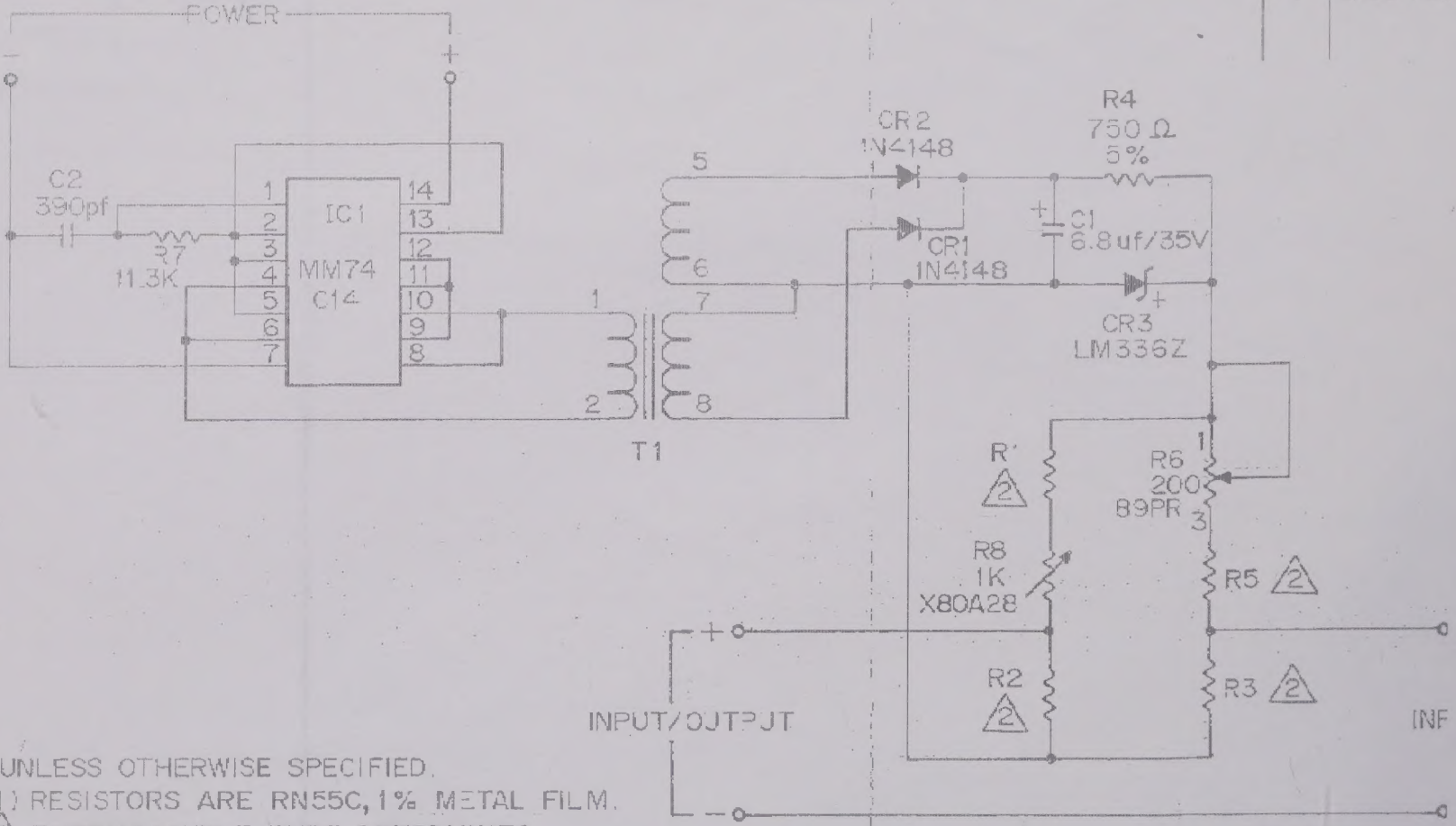
Released For Production _____ Date _____

Approved By _____ Date _____

3		ADD "G" COLUMN TO TABLE ON SHT 2 AND ADD "G" TO P/L IDENTIFICATION	2	PE	JM	
4	SHT	IN G COLUMN R2, R3 ARE 1.0 OHM R1 IS 2.80 KOHN R5 IS 3.32 KOHN	2	ER	JM	7-11-90
10	2 3	P/N WAS MM74C14 IS MM74C14N ECN 384 ..... IN4148D 1N4148	2	ER	JM	

FOR ACCUTS EXPRESS. YOU
PROPRIETARY, DESIGN, I

REV. NO.	
1	CHG'D PER



NOTES: UNLESS OTHERWISE SPECIFIED.
1) RESISTORS ARE RN55C, 1% METAL FILM.
2 THERMOCOUPLE TYPE DETERMINES RESISTOR VALUES.

		TOLERANCE: UNLESS OTHERWISE SPECIFIED DECIMALS: XX ± .03 XXX ± .010 ANGLES: ± 1°	CUSTOMER
		MATERIAL:	TITLE: SCHEMATIC X85 COLD JUNCTION COMPENSATION CIRCUIT
		FINISH:	DRAWN CHECKED ENGINEER MANUFA
NEXT ASSY	USED ON		

P.10/10
JUN 07 '96 10:59AM RONAN ENGINEERING LA

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DESCRIPTION	APPR	DATE	BY
SEE E.C.O. NO. 739.		3/2/84	M.A.

INPUT/OUTPUT

+

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DRAWN	M.A.	3/8/83
DESIGN		
ENGINEER	JBM	3/8/83

DATE

BOMAR

BOMAR INTERLOCK, INC.